COHU, INC.
ELECTRONICS DIVISION

Installation, Operation and Maintenance Manual for 6510 CCD MONOCHROME CAMERA

Technical Manual No. 6X-885

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ELECTRONICS DIVISION
SAN DIEGO CALIFORNIA

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WARNING

This Camera operates from line voltage that can be fatal if contacted. Always use a grounded three-wire power receptacle when connecting the line cord. When working inside the Camera, use all appropriate methods to avoid electrical shock.

CAUTION

ELECTROSTATIC
SENSITIVE
DEVICES

**DO NOT OPEN OR HANDLE
EXCEPT AT A
STATIC-FREE WORKSTATION**

NOTE

The Camera Head and Camera Control Unit (CCU) are a matched pair. To ensure compatibility, they should be operated only as a pair—not mixed with other units.

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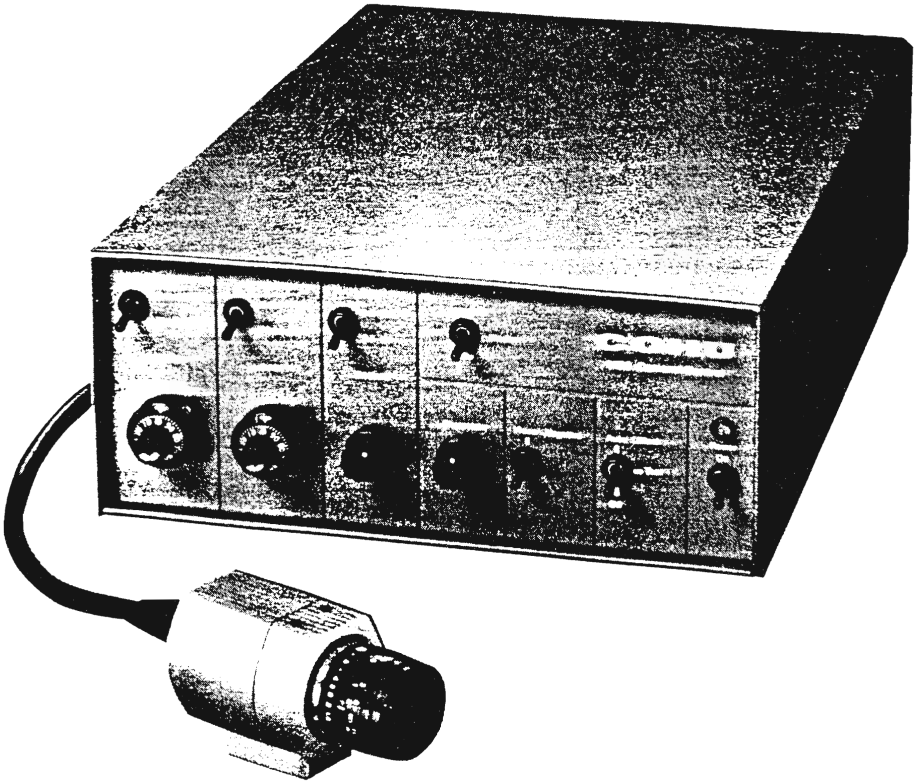


Figure 1-1. Model 6510 Camera

Figure 1-1. Model 6510 Camera

SECTION I
GENERAL DESCRIPTION

This manual contains installation, operation, and maintenance instructions for a miniature Camera Head and its Camera Control Unit (CCU), shown in figure 1-1. They are intended for scientific monochrome applications requiring a small lightweight Camera. A 4.6-meter (15-foot) fixed-length cable interconnects the Camera Head and CCU.

1.1 ELECTRICAL CHARACTERISTICS

Table 1-1 gives specifications. Use table 1-2 to interpret the Camera model number. Breaking down the model number determines the options contained in a Camera.

The Camera Head contains a 1/2-inch-format Charge Coupled Device (CCD) image sensor and related support circuits. Active imaging area is 6.4 by 4.8 mm, with an array of 739 horizontal by 484 vertical picture elements.

This sensor uses the frame transfer method. Each field is integrated on the sensor surface, transferred into storage, then read out a line at a time during the period on the next field.

Figure 1-2 shows the response characteristic of the optional IR blocking filter. This filter is permanently mounted inside the Camera Head when this option is provided. It cannot be removed.

Signal-to-noise ratio is sufficient to allow 8-bit digitization with 256 gray levels.

The CCU rear panel provides inputs for:

- 115 V ac 60 Hz power
- Composite sync or video
- Horizontal drive
- Vertical drive
- Integration start/end

Outputs provided are:

- 1 V p-p composite video
- Horizontal trigger
- Vertical trigger
- Integration grab pulse
- 4.77 MHz clock

The CCU offers a full range of operator switches and controls for:

- Power on/off
- Auto black on/off
- Stairstep test signal on/off
- Video negative/positive
- Sharpness 6 dB control
- Gamma variable 0.5 to 1.5
- 20 dB agc gain
- 20 dB manual gain
- Preset fixed or
- Offset control +5 to -85 IRE units

Refer to section II of this manual for input and output signal characteristics of rear panel connectors.

Refer to section III for a listing of front panel operator controls and their operating characteristics.

1.2 MECHANICAL CHARACTERISTICS

Since the Camera Head contains only the sensor and supporting circuits, it is a small compact unit. A permanently attached cable connects the Camera Head to its companion CCU.

The CCU contains all other electronics required to support the sensor in the Camera Head. The CCU also provides all operator controls on its front panel and interconnections on its rear panel.

1.2.1 Camera Head

Compact design of the Head makes it suitable for applications requiring light weight and minimum obtrusion of a Camera into the viewing environment.

A C-mount adapter (fig. 2-7) accepts most types of fixed-focus tv lenses.

For mounting the Camera Head, two 6-32 holes are provided on both top and bottom flat surfaces (fig. 1-3). Either surface can be used for mounting to a suitable support. An adaptor plate is provided for mounting with a single 1/4-20 bolt.

1.2.2 Camera Control Unit

The CCU is also a compact, lightweight unit (fig. 1-4). All interfacing connectors and the fuse holder are located on the rear panel for easy access (fig. 2-1).

The case sits on four feet. A fold-down stand can be used to elevate the front of the CCU for easier control accessibility when it sits on a low work surface.

Removal of two screws on each side of the case gives access to the interior. Once the case is lifted off, the two circuit boards and other features inside are accessible. Removing two screws allows the top (sync/genlock) board to be hinged up for complete access to the lower (video/auto/power-supply) board.

1.3 POWER REQUIREMENTS

The CCU has a permanently attached rear panel line cord. It must be plugged into 115 V ac power ±10%. The ac power must be 60 Hz.

1.4 EQUIPMENT SUPPLIED

The following items are the minimum typically supplied with each Camera:

1. Technical Manual

2. C-mount adapter (See fig. 2-7)

3. Plug for J34 (auxiliary/sync) on rear panel

If a lens was ordered with the Camera, it too would be provided. However, since cameras are often ordered without a lens, this option is listed in section 1.5 as equipment required but not supplied.

Plugs are not supplied for rear panel connectors to which a cable is provided. These interconnection cables may be supplied with other equipment that interconnect with the Camera.

1.5 EQUIPMENT REQUIRED BUT NOT SUPPLIED

The following items are the minimum required to obtain a picture from the Camera.

1. Lens, C-mount (sensor is 1/2 inch format)

2. 75 ohm coaxial cable (picture monitor interconnection)

3. RS-170 monochrome picture monitor

1.6 WARRANTY

The warranty appears on the inside of the rear cover.

Table 1-1. Specifications

ELECTRICAL	
Imager	Single CCD using frame transfer method
Image Area	6.4 x 4.8 mm (1/2-inch format)
Active Picture Elements	739(H) x 484(V)
Number of Picture Elements	774(H) x 242(V)
Cell Size	8.5 µm (H) x 19.75 µm (V)
Resolution	Horizontal: 560 tv lines Vertical: >350 tv lines
Sensitivity	(2850 K faceplate illumination) See chart 1 and table 1-1A
Contrast Variation	<5% overall at 25 °C (Gamma 1, gain 0 dB)
Video Output	1.0 Vp-p, 75 ohm, unbalanced
Gamma	Continuously variable 0.5 to 1.0 and 1.0 to 1.5, switch selectable
Gain	Switch selectable, manual or agc, 20 dB range
Auto Black	Maintains setup level at 7.5±5 IRE units if picture contains at least 10% black
Signal-to-Noise Ratio	56 dB (gamma 1, gain 0 dB, aperture flat) 8-bit capability for digitization with 256 gray levels
Aperture Enhancement	6 dB peak at 6 MHz
Offset	+5 to -85 IRE units
Shutter, switch selectable	Off: standard (1/60 s) Low: 1/1000 s High: 1/2000 s
Sync References	RS-170 crystal, 14.31818 MHz (4.77 MHz clock output) Genlock (with horizontal phase adjustment) Line lock, zero crossing, selectable in 60° increments, 0° to 300°, with phase trim adjust External H and V drive (Revert to line lock or crystal, jumper selectable, with loss of input sync reference)
Power Requirement	115 V ac ±10%, 60 Hz, fuse protected, 6 foot power cord
Power Consumption	10 watts

ENVIRONMENTAL	
Ambient Temperature Limits	Operating: -10 to 50 °C (14 to 122 °F) Storage: -30 to 70 °C (-22 to 158 °F)
Humidity	Up to 95% relative humidity, noncondensing
Vibration	5 to 60 Hz with 0.082 inch total excursion (15 g's at 60 Hz). From 60 to 1000 Hz, 5 g's rms random vibration without damage.
Shock	Up to 15 g's in any axis under nonoperating conditions per MIL-E-5400R, paragraph 3.21.24.6
Altitude	Sea level to equivalent of 3048 meters (10,000 feet) [20 inches of mercury]
MECHANICAL	
Dimensions	See fig. 1-2 and 1-3
Weight	Camera head, less lens 113 grams (4 oz) CCU, 2.3 kg (5 pounds)
Lens Attachment	C-mount
Lens	Accepts most types of manual tv lenses
Camera Head Mounting	6-32 holes top (2) and bottom (2), adaptor provides single 1/4-20 hole (fig. 1-2)
Connectors	See fig. 2-1 and table 2-1

See table 1-2 for model number interpretation

Cohu reserves the right to change specifications without notice

Table 1-1A. Faceplate Sensitivity

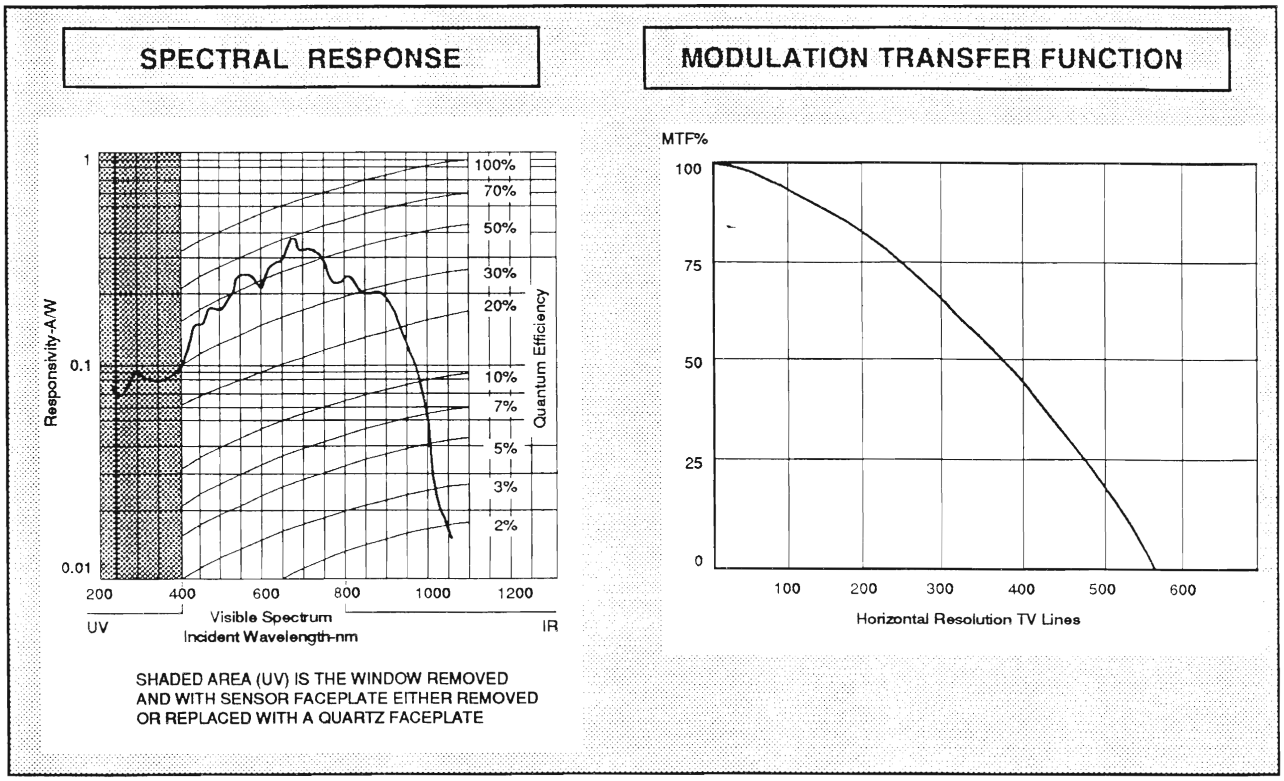
FACEPLATE SENSITIVITY	With IR filter	Without IR Filter
Full video, *manual gain mode	3.8 lux (0.38 fc)	0.40 lux (0.04 fc)
90% video,**agc/auto mode	0.32 lux (0.032 fc)	0.034 lux (0.0034 fc)
Usable video#	0.1 lux (0.01 fc)	0.012 lux (0.0012 fc)

*Manual gain control fully ccw

**Agc holds video at 90% final 20 dB to light level specified

#30% video at light level specified; agc or manual gain at maximum

Chart 1



SHADED AREA (UV) IS THE WINDOW REMOVED AND WITH SENSOR FACEPLATE EITHER REMOVED OR REPLACED WITH A QUARTZ FACEPLATE

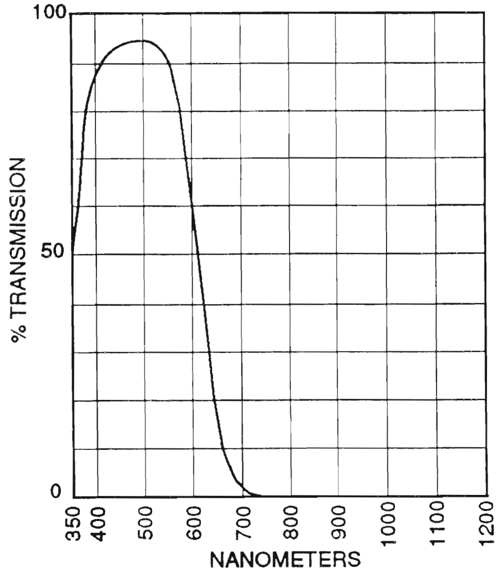


Figure 1-2. Response Characteristic Optional IR Blocking Filter

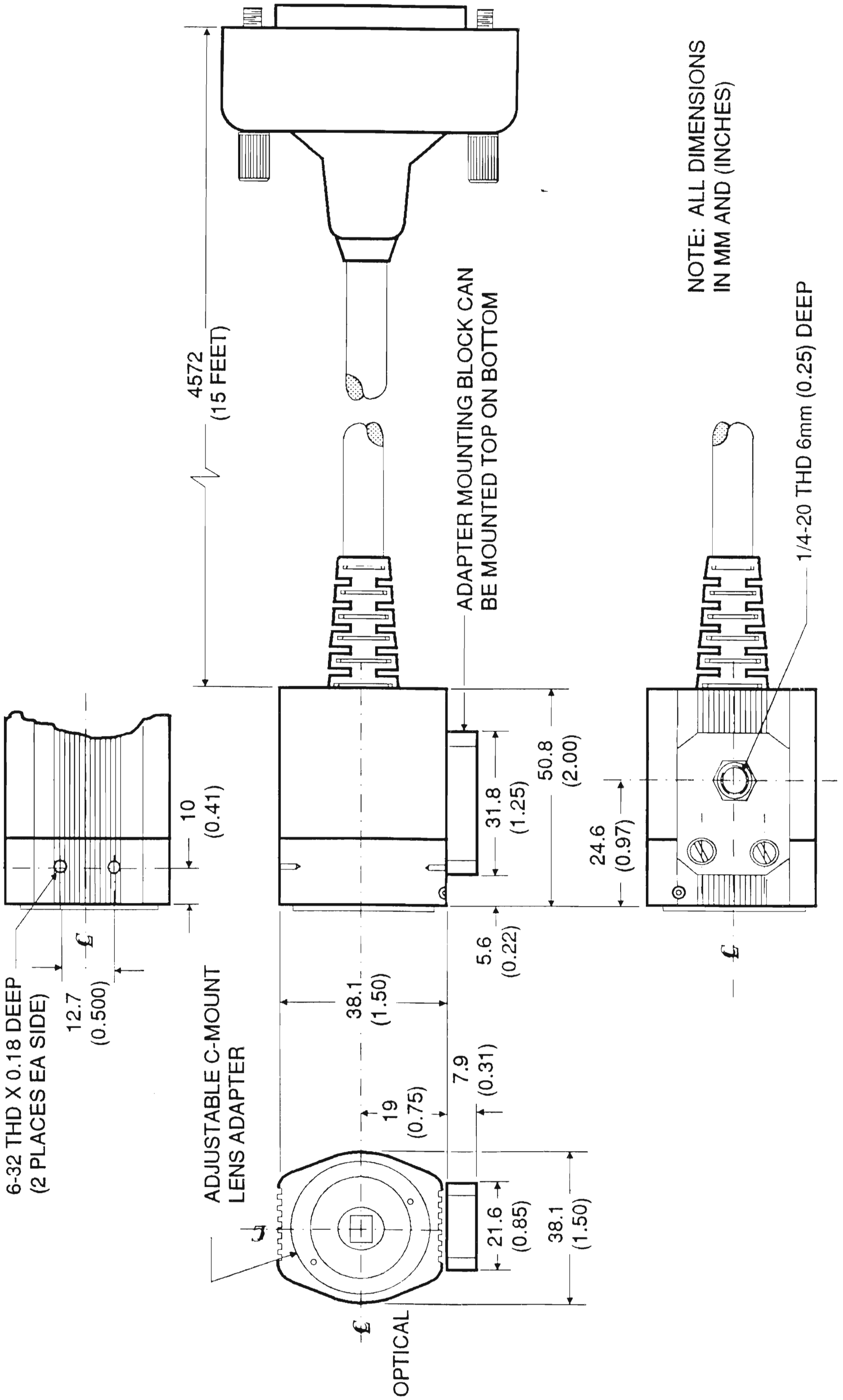
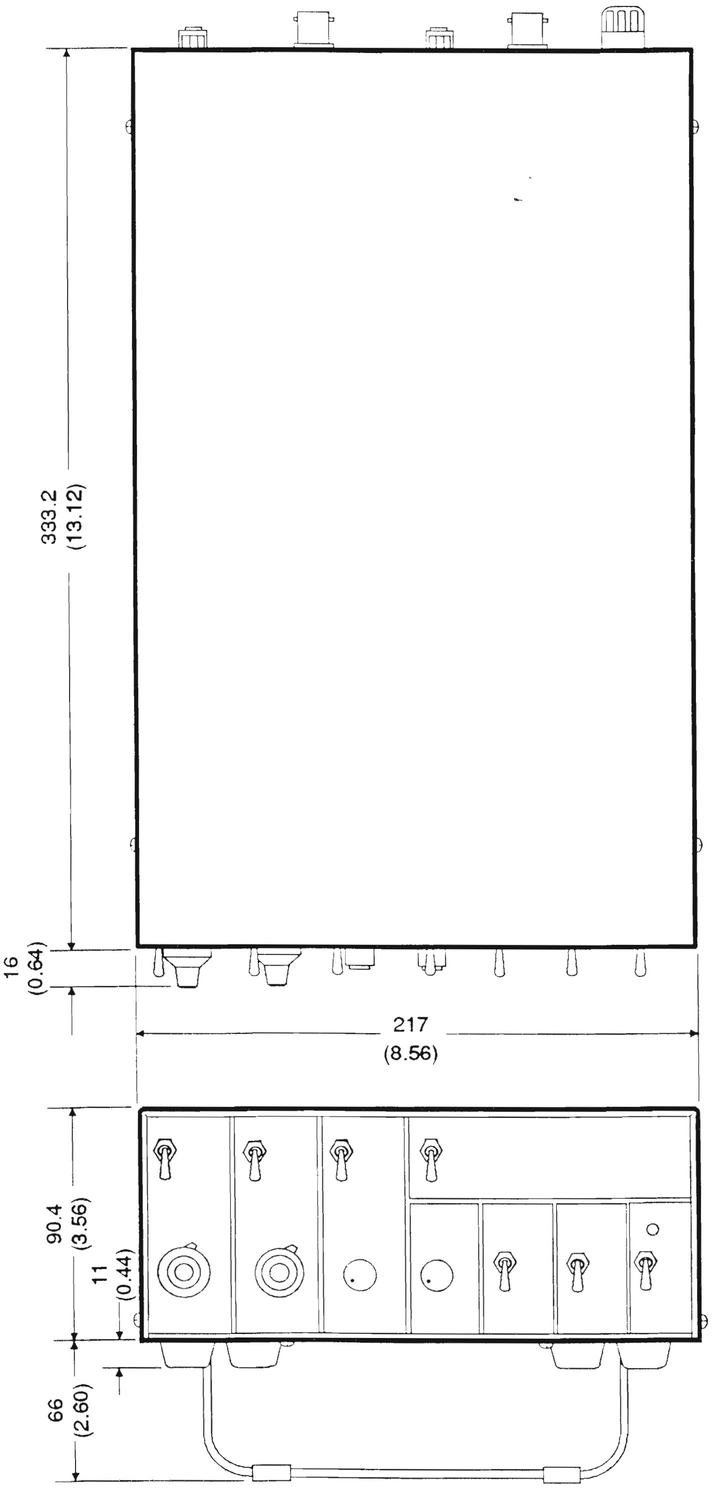


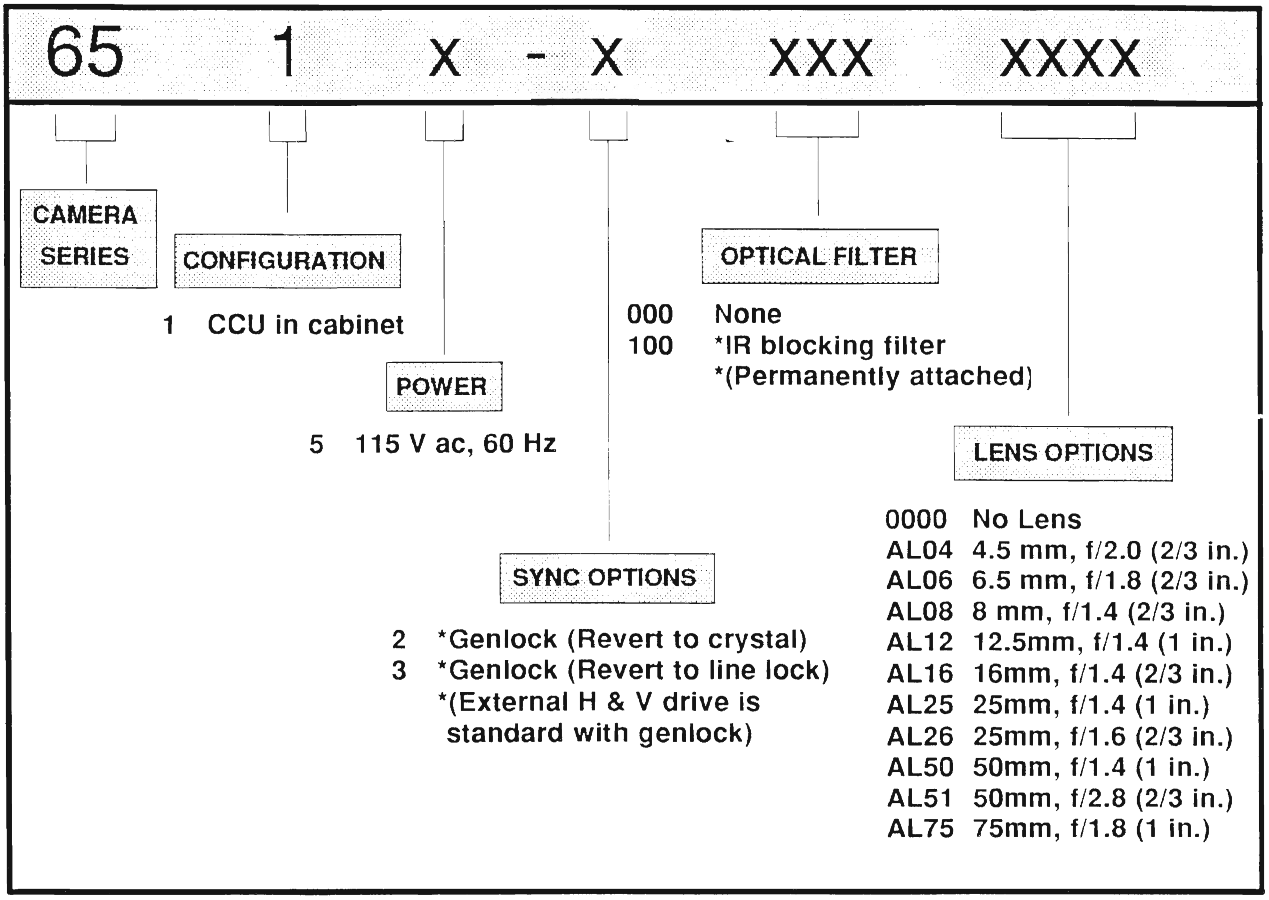
Figure 1-3. Dimensions, Camera Head



NOTE: ALL DIMENSIONS
IN MM AND (INCHES)

Figure 1-4. Dimensions, Camera Control Unit

Table 1-2. Model Number Interpretation



65 1 X - X XXX XXXX

CAMERA SERIES

CONFIGURATION

1 CCU in cabinet

POWER

5 115 V ac, 60 Hz

SYNC OPTIONS

2 *Genlock (Revert to crystal)
3 *Genlock (Revert to line lock)
*(External H & V drive is standard with genlock)

OPTICAL FILTER

000	None
100	*IR blocking filter *(Permanently attached)

LENS OPTIONS

0000	No Lens
AL04	4.5 mm, f/2.0 (2/3 in.)
AL06	6.5 mm, f/1.8 (2/3 in.)
AL08	8 mm, f/1.4 (2/3 in.)
AL12	12.5mm, f/1.4 (1 in.)
AL16	16mm, f/1.4 (2/3 in.)
AL25	25mm, f/1.4 (1 in.)
AL26	25mm, f/1.6 (2/3 in.)
AL50	50mm, f/1.4 (1 in.)
AL51	50mm, f/2.8 (2/3 in.)
AL75	75mm, f/1.8 (1 in.)

> ***NOTE***
>
> *The Camera Head and Camera Control Unit (CCU) are a matched pair. To ensure compatibility, they should be operated only as a pair—not mixed with other units.*

SECTION II
INSTALLATION

This section of the manual describes how to install the Camera. Since a Camera can be used in many different applications, the installer will have to adapt the information provided here to the particular installation. Adjustments and jumper changes listed in this section are not mandatory setup adjustments. They are required only if the Camera must be made to operate under conditions different than those provided for by the current settings.

Figure 2-1 shows the CCU rear panel. All interface connectors appear here. Table 2-1 lists these connectors and their mating plugs.

2.1 UNPACKING AND RECEIVING INSPECTION

This item was thoroughly tested and carefully packed in our factory. Upon acceptance by the carrier, they assume responsibility for its safe arrival. Should you receive this item in a damaged condition, apparent or concealed, a claim for damage must be made upon the carrier. If it is necessary to return the product to the factory for service, please contact the Customer Service department for a Return Authorization (RA) Number.

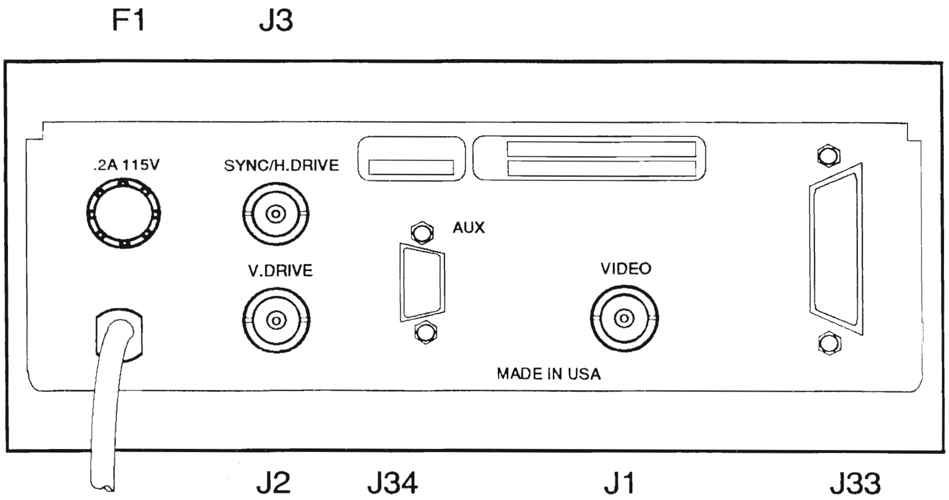


Figure 2-1. Rear Panel, CCU

Table 2-1. Connectors and Mating Plugs

NAME	CAMERA REAR PANEL CONNECTOR		MATING CONNECTOR FOR CABLE	
VIDEO (J1)	P.N. 1310242-001	BNC Jack	BNC Plug	-
V. Drive (J2)	P.N. 1310242-001	BNC Jack	BNC Plug	-
Sync/H. Drive (J3)	P.N. 1310242-001	BNC Jack	BNC Plug	-
CAMERA (J33)	P.N. 7610139-001*	D-25 Male	-	Amp HDE-20
AUX (J34)	P.N. 7610138-001*	D-9 Female	1310136-003	Cannon DB-9P

*Cable Assembly

If upon receipt of this shipment a visual inspection shows damage, it must be noted on the freight bill or express receipt and the notation signed by the carrier's agent. Failure to do this can result in the carrier refusing to honor the claim.

When damage is not apparent until the unit is unpacked, a claim for concealed damage must be entered. When concealed damage is discovered, make a mail or phone request to the carrier for inspection. Keep all cartons and packing materials. The request for inspection should be made immediately upon discovery of concealed damage. Since shipping damage is the carrier's responsibility, the carrier will furnish you with an inspection report and necessary forms for filing the concealed-damage claim.

2.2 PREPARATION FOR SHIPMENT OR STORAGE

For storage periods exceeding approximately one month, seal the unit in a vapor-proof bag containing a fresh desiccant pack. The storage environment must be maintained within -30 to 70 °C. For shipment, pack with sufficient foam padding or other suitable packing material to prevent damage by sudden shock loads or crushing that may occur during shipping. The original shipping carton is a good container if it has not been damaged or subjected to excessive moisture.

For shipping to the factory by Common Carrier, use 5755 Kearny Villa Road, San Diego, CA 92123 as the address. Please contact the Customer Service Department for a Return Authorization Number before sending any shipments to the factory.

2.3 INSTALLATION PROCEDURE

CAUTION

Do not connect or disconnect the Camera Head cable to the CCU when power is on. Use all standard static precautions at exposed connector pins when they are not mated.

NOTE

The Camera Head and Camera Control Unit (CCU) are a matched pair. To ensure compatibility, they should be operated only as a pair—not mixed with other units.

Installation consists of (1) installing lens (and verifying back focus when the Camera is operational), (2) mounting the Camera Head at its location, (3) placing the CCU at the operator's station, (4) interconnecting the Camera Head with the CCU, and (5) then as required connecting cables for video and sync/auxiliary functions.

2.4 POWER CONNECTION

The Camera has a 6 foot long permanently attached line cord. Connect it to 115-V ac 60-Hz power. An AGC type 0.2 amp slow-blow fuse (F1) is used in the rear panel fuse holder.

2.5 VIDEO CONNECTION

Figure 2-2 shows the BNC video output connector (J1) and a standard RS-170 video waveform. This video waveform can be modified by settings of operator controls on the front panel of the CCU. For example, white and black are inverted when the front panel **Video Negative** switch is positioned up to **Negative**.

If the **OFFSET** switch is set to **Manual** and the related control rotated clockwise, the peak-to-peak envelope can be shifted downward into blanking. Rotated fully cw, the control places the video envelope 85 IRE units (38 dB) lower. The envelope remaining above blanking can then be expanded (up to 20 dB) with the **Manual GAIN** control or by the agc when in the **Auto** mode.

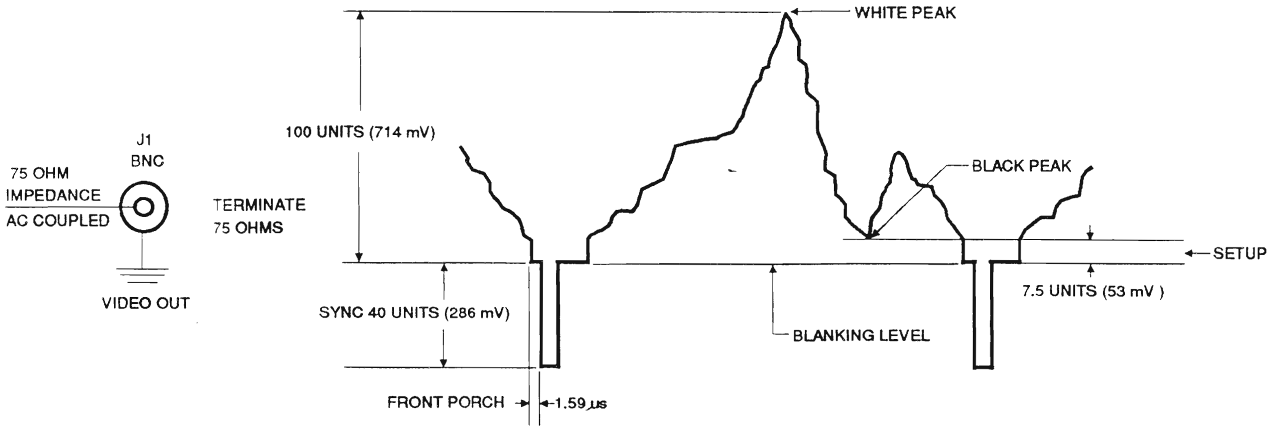
Use 75-ohm (RG-59/U) coaxial cable to interconnect the Camera with a picture monitor or other viewing device. It must be terminated with a 75 ohms. Multiple viewing devices may be operated with loop-through connections, but only the last unit should be terminated with 75 ohms. All other units between the Camera video output and the last unit should be unterminated or have their termination switch set to high impedance.

2.6 SYNC / H.DRIVE CONNECTION

Figure 2-3 shows the sync / horizontal drive input connector (J3). This input is shown with the required input waveform.

2.7 V. DRIVE CONNECTION

Figure 2-4 shows the vertical drive input connector (J2) and related waveform.



(STANDARD WHITE POSITIVE VIDEO SHOWN. OPERATOR CONTROLS CAN MODIFY THIS AND OTHER CHARACTERISTICS)

Figure 2-2. Video Output (J1)

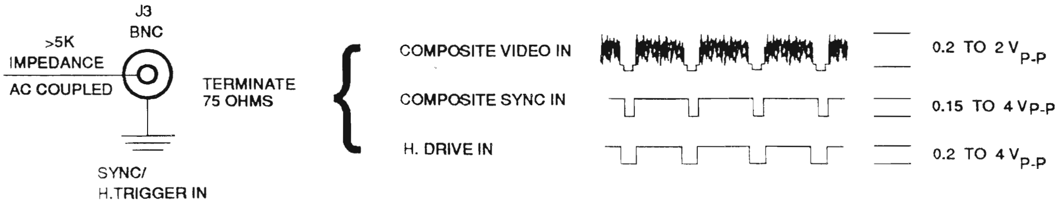


Figure 2-3. Sync/Horizontal-Drive Input (J3)

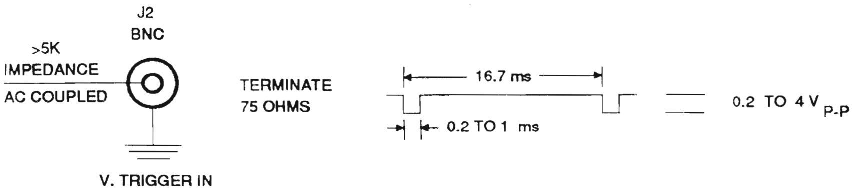
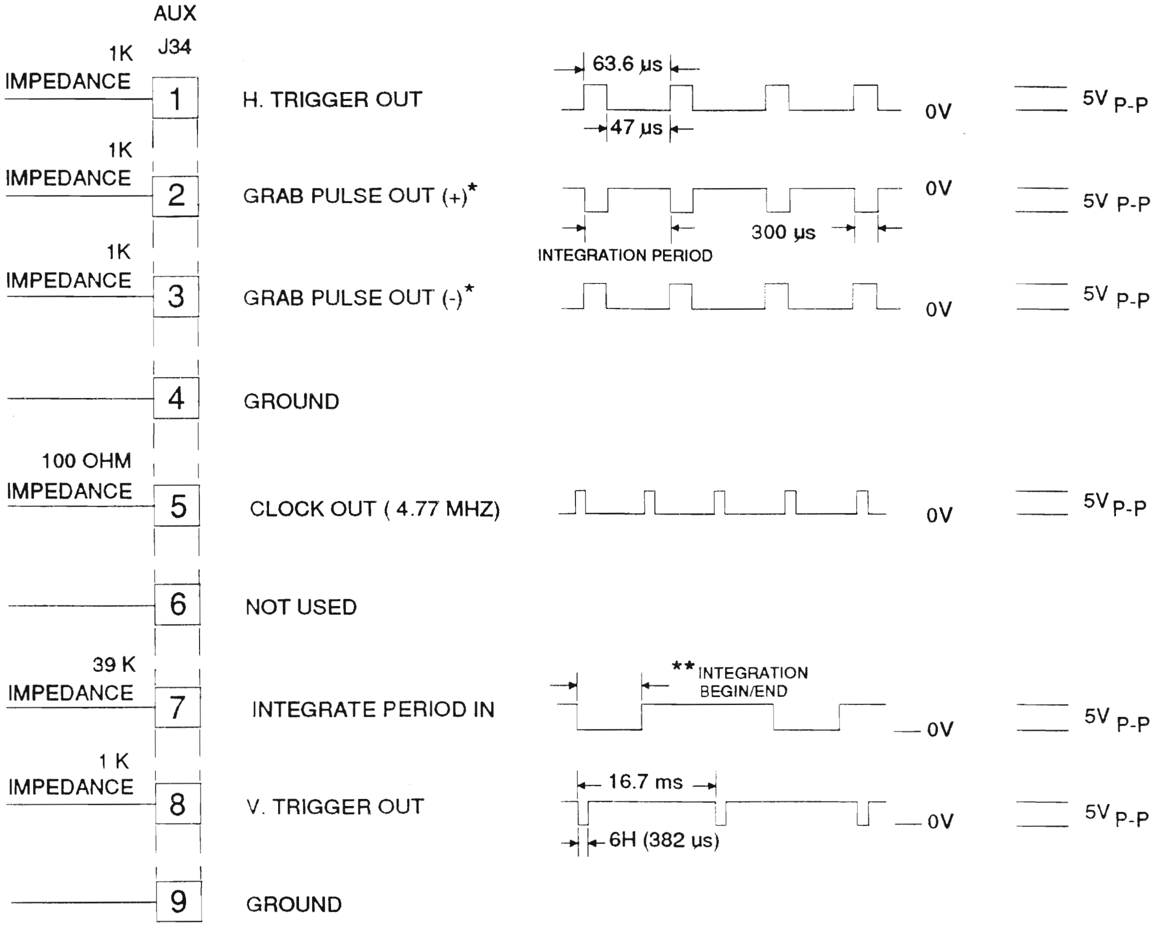


Figure 2-4. Vertical Drive Input (J2)

The vertical drive input is used in conjunction with a horizontal drive input being applied to J3.

2.8 AUXILIARY CONNECTIONS

Figure 2-5 shows the auxiliary connector (J34) with typical inputs and outputs. The auxiliary connector provides sync, horizontal drive, and vertical drive inputs and outputs. It also provides an input to begin and end integration and a grab pulse complementary output for use with a frame grabber. Waveforms are shown in the figure.



ALL INPUTS AND OUTPUTS ARE DC COUPLED

*GRAB PULSE LEADING EDGE CAN BE CONCIDENT WITH EITHER THE TRAILING EDGE OF THE INTEGRATE PERIOD PULSE OR WITH LEADING EDGE OF THE VERTICAL DRIVE/VERTICAL BLANKING PULSE FOLLOWING THAT, DEPENDING ON AN INTERNAL JUMPER (SEE FIG. 2-6)

** INTEGRATION BEGINS AND ENDS WITH THE BLANKING INTERVALS FOLLOWING THESE LEADING AND TRAILING EDGES

Figure 2-5. Auxiliary Inputs/Outputs (J34)

2.8.1 Horizontal Trigger Output (J34-1)

This output provides a standard 5 V p-p waveform. The leading edge is coincident with the leading edge of horizontal sync.

2.8.2 Vertical Trigger Output (J34-8)

This output provides a standard 5 V p-p waveform. The leading edge is coincident with the leading edge of vertical blanking.

2.8.3 Grab Pulse Output (J34-2, J34-3)

This is a complementary output. The pulse occurs at the end of the integration period (fig. 2-6). The leading edge can have either of two positions, depending on an internal jumper (V DRIVE / PRE GRAB POS) on the sync/genlock circuit board. The leading edge can be coincident with either:

1. The leading edge of vertical drive immediately following the removal of the integration pulse.

2. The trailing edge of the integration pulse.

Consult specifications of the frame grabber to determine which of these two timings should be used.

2.8.4 Integrate Period Input (J34-7)

When the input is taken low, integration begins with the next vertical blanking pulse. When the input is taken high, integration ends with the next vertical blanking pulse. Note that integration begins and ends with the vertical blanking interval, not at the exact time of application and removal of the integration pulse.

The minimum integration period is two fields. The maximum period is about four seconds—limited by deterioration of picture quality. It is best to perform tests to determine acceptable picture quality vs integration period for an intended application.

For applications requiring the longer integration periods, maintaining the Camera Head (sensor IC) at a reduced temperature will enhance picture quality.

When integration is initiated, the sensor is switched to the non-interlaced mode.

2.9 LENS INSTALLATION AND BACK-FOCUS ADJUSTMENTS

Figure 2-7 gives dimensions and other data for the C-mount adapter. The sensor has a one-half inch format. When selecting a lens of other than 1/2-inch format, be sure that the focal length provides the desired field of view. The optional IR-rejecting filter is installed in place of a clear glass window in front of the sensor IC (see fig. 5-5). The filter or window is permanently attached. Figure 1-4 shows response of the IR filter.

It is useful when scene illumination will vary between light with large amounts of IR (sunlight or incandescent bulbs) and light with little IR (fluorescent).

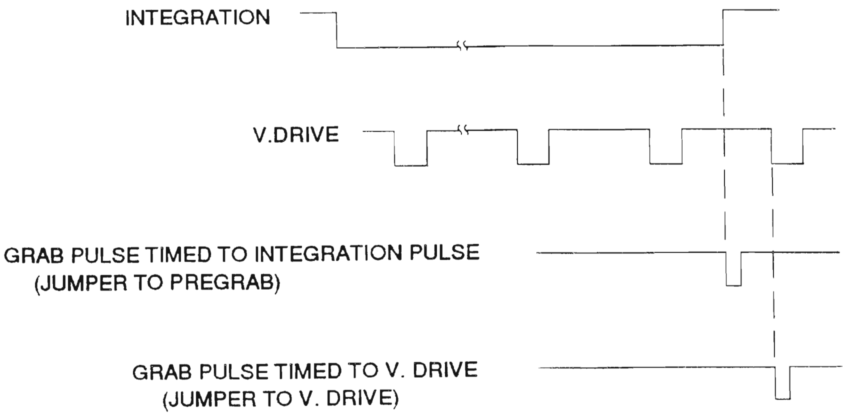

INTEGRATION
V.DRIVE
GRAB PULSE TIMED TO INTEGRATION PULSE
(JUMPER TO PREGRAB)
GRAB PULSE TIMED TO V. DRIVE
(JUMPER TO V. DRIVE)

Figure 2-6. Timing Diagram, Grab Pulse

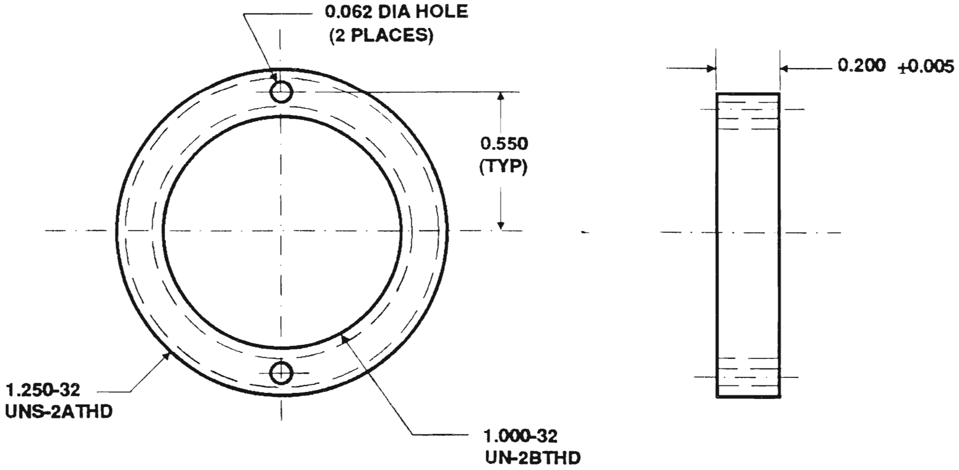


Figure 2-7. Dimensions, C-Mount Adapter

Use low-pressure dry compressed air to clean the window area. Never rub an optical surface with dry tissue. Use methyl alcohol or a similar optical-quality solution and lens tissue. The sensor faceplate (located behind the window (or optional IR filter) is a focal-plane area. Dust, lint, and other contaminants on that surface would be superimposed on the scene. This is a sealed area. It is cleaned during assembly at the factory with dry nitrogen that is ionized to prevent dust from "sticking" in that area due to static charge.

To install a lens, proceed as follows:

1. Remove the plastic plug installed in the lens adapter opening.

2. As required, clean the lens and the window (or optional IR filter) in front of the faceplate of the image sensor

3. Screw the lens to finger tightness into the C-mount adapter.

4. Set the lens focusing ring to infinity.

5. Point the lens at a distant scene well into the infinity focusing distance of the lens.

6. Place sufficient neutral density filters in front of the lens so the lens iris is fully open and normal video output is present.

7. Note whether the scene is in sharp focus. If it is, no further adjustments are required.

8. If the scene is out of focus, loosen the C-mount setscrew (5/64 in. Allen wrench) and rotate the lens and C-mount as a unit in and out of the Camera Head until the scene is in focus.

CAUTION

ELECTROSTATIC SENSITIVE DEVICES

DO NOT OPEN OR HANDLE EXCEPT AT A STATIC-FREE WORKSTATION

9. Snug down the setscrew; do not over tighten.

2.10 USER ADJUSTMENTS

Refer to procedures in section V of the maintenance manual if further adjustments are necessary after a Camera is out of warranty. Section V provides complete test setup and adjustment procedures for Camera circuits.

NOTE

Perform only the adjustments covered in this section of the manual when required. Making any other adjustment or change may void the warranty of an in-warranty Camera.

2.10.1 CCU Case Removal

WARNING

This Camera operates from line voltage that can be fatal if contacted. Always use a grounded three-wire power receptacle when connecting the line cord. When working inside the Camera, use all appropriate methods to avoid electrical shock.

Two screws must be removed on each side of the CCU case before it can be lifted off the chassis. The two screws are standard cross slotted (Phillips) types. After the screws are removed, lift the case straight up off the chassis.

2.10.2 Alternate Setup Adjustments

Cameras are adjusted at the factory for operation under typical conditions, with most functions automatically controlled. Some adjustments and jumpers can be changed. But this should only be required when the Camera must operate under conditions different from those currently provided for. These changes can be made without elaborate test setups, but only technically qualified persons should attempt them.

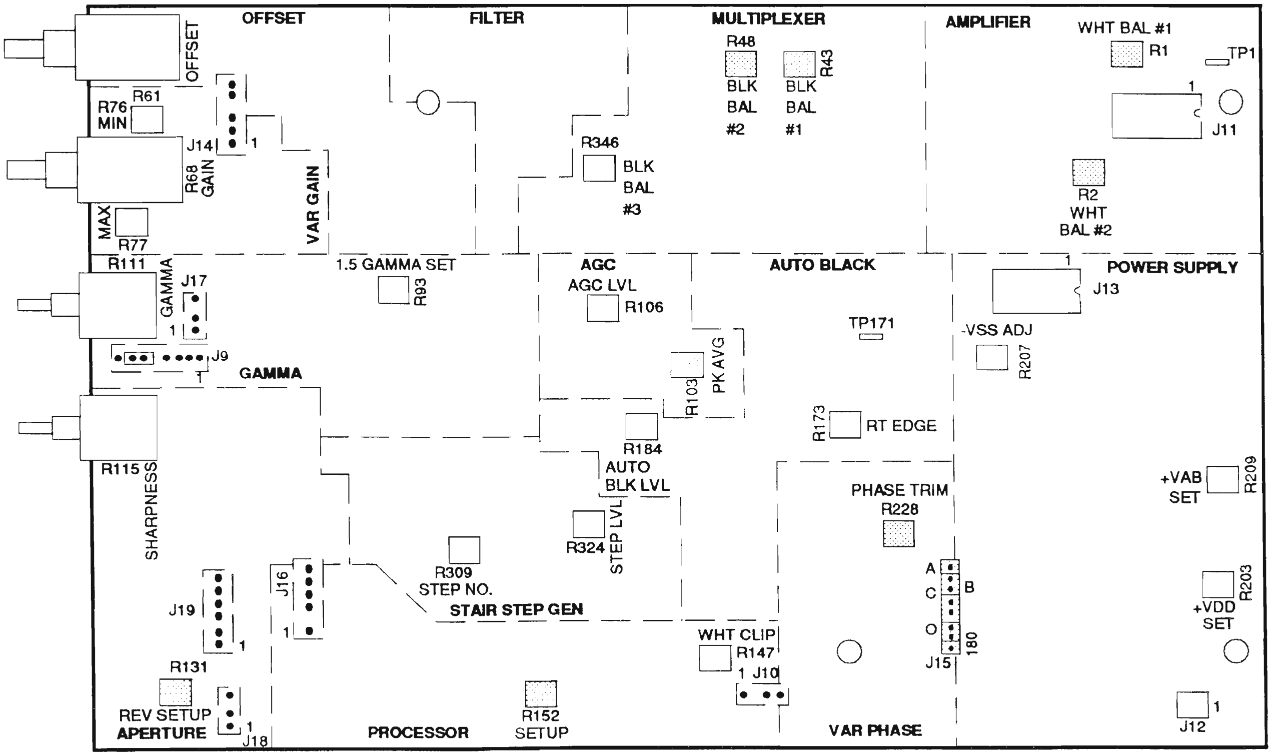


Figure 2-8. Adjustment Locations, Video/Auto/P.S. Board

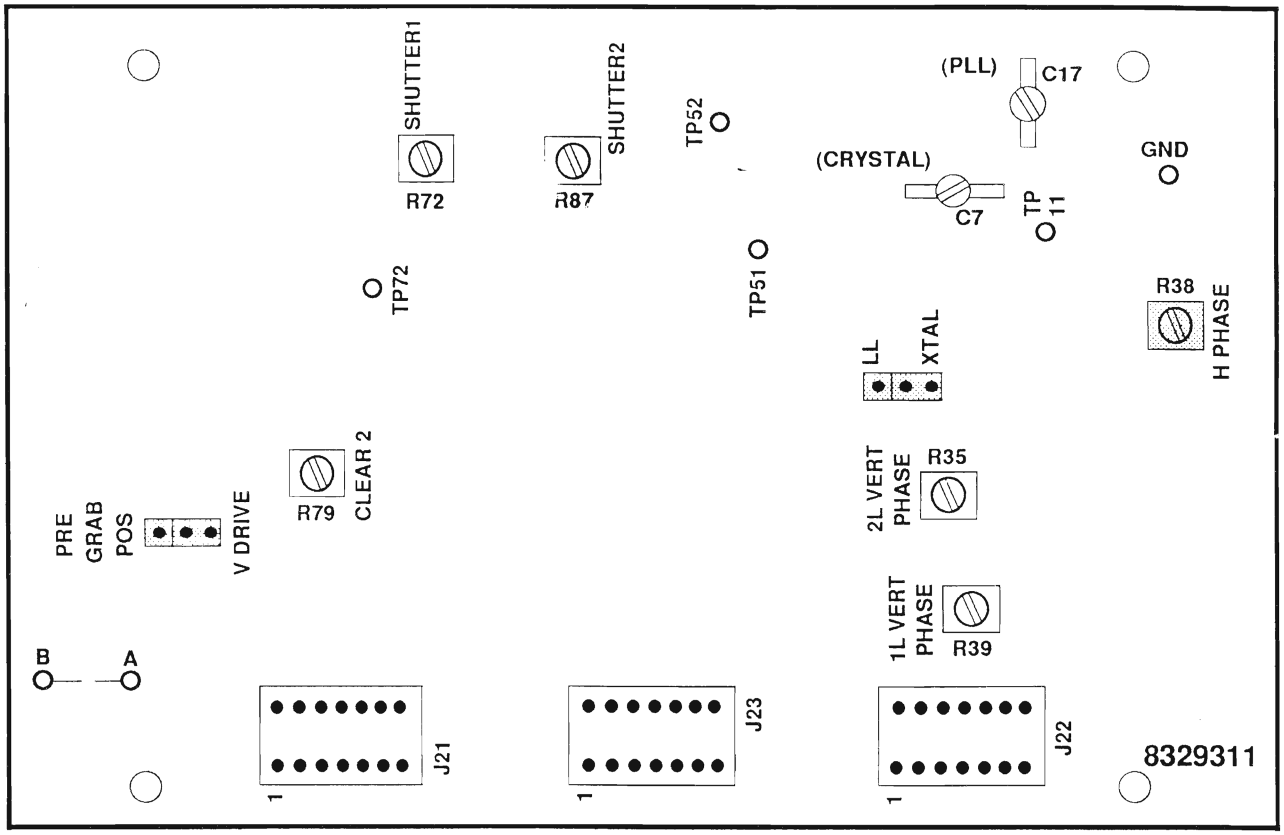


Figure 2-9. Adjustment Locations, Sync/Genlock Board

Table 2-2 describes changes that can be made as part of an installation when it is required to set up the Camera for different operating conditions. Use the table to make any required changes .

Figures 2-8 and 2-9 show all adjustments and jumpers on the CCU Video/Auto/P.S. board and Sync/Genlock board. Only those adjustments and jumpers shown with shading may be changed when using table 2-2.

Section V of the maintenance manual covers these and all other adjustments. It shows test equipment setups and gives complete procedures for making adjustments. Many of these must be done in proper sequence. No adjustments beyond those listed in this section should be performed on an in-warranty Camera. Making any other adjustment may void the warranty.

NOTE

If any of the listed adjustments do not produce normal operation, refer to section V of the maintenance manual for troubleshooting suggestions. Or if desired, return the Camera to the factory for service. Be sure to obtain a Return Authorization (RA) number from the factory before returning the Camera. This number should be plainly marked on the box and on all paperwork. Provide complete, detailed information about the specific nature of the problem.

Table 2-2. Adjustments

ADJUSTMENT/JUMPER	PURPOSE
	VIDEO/AUTO/POWER SUPPLY BOARD
SETUP (R152)	This potentiometer establishes video setup (black) level for normal (non inverted) video when in the **Off** position of the **Black** switch. (The **Video Negative** switch must be positioned down.)
REVERSE SETUP (R131)	This potentiometer establishes video setup (black) level for negative (inverted) video when the **Black** switch is in the **Off** (non **Auto**) position. The **Video Negative** switch must be positioned up to establish negative video. (The **Setup** potentiometer, R152, is still in the circuit when negative video is selected.)
BLK BAL #1 and **BLK BAL #2** (R43 and R48)	Set **Auto Black** to **Off** and **Auto Manual GAIN** to **Auto**. Reduce light to obtain about 80 units. Adjust R43 and R48 to minimize interference in the black areas.
WHT BAL #1 and **WHT BAL #2** (R1 and R2)	Adjust R1 and R2 to minimize interference in the white and gray areas. Readjust black and white balance as necessary to minimize interference.
PEAK-AVG (R103) (ccw-cw)	Adjusts agc sensing between peak detect (ccw) and average (cw) detect. In the peak detect position, agc holds video peaks to a maximum of 100 IRE units; in the avg (average) detect position, agc averages the video to the 100-unit level.
0° - 180° jumper	Establishes basic phase of 60-Hz signal for line-lock sync reference. Used in conjunction with the 60° increment jumper positions (A, B, and C).
A-B-C jumper	Shifts line-lock sync reference in 60° increments. Used with the **0 - 180** jumper to provide line-lock sync references from 0° to 300°.
PHASE TRIM (R228)	Makes fine adjustments to the 60° step-phase setting of the repositionable jumpers.
	SYNC/GENLOCK BOARD
H. PHASE (R38)	When the Camera operates from external sync, this adjustment makes it possible to position Camera output sync in relation to the reference sync. When making this adjustment, observe the two sync pulses at the location where time coincidence is required .
V.D. - Pregrab jumper	Determines whether the grab pulse output from the ccu is coincident with the integration on/off input pulse trailing edge(**Pregrab** position) or with the vertical drive pulse (**V.D.** position) leading edge following application of that pulse.

SECTION III
OPERATION

3.1 CCU CONTROLS

Controls accessible to an operator are described in this section of the manual. Refer to table 3-1 for a listing of operator controls and their functions. All operator controls are on the front panel of the CCU.

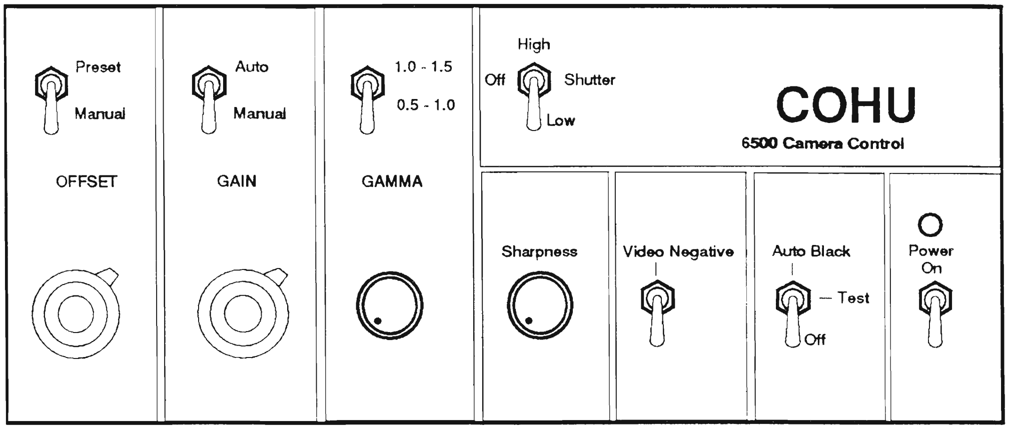


Figure 3-1. Camera Control Unit Front Panel

For typical operating condition with normal light levels, place the front panel controls as follows:

Power	**On**
Black	**Auto**
Video Negative	down
Sharpness	fully ccw
Shutter	**Off**
GAMMA switch	**0.5 - 1.0**
GAMMA control	(See below)
GAIN switch	**Auto**
GAIN control	Does not function in **Auto**
OFFSET switch	**Preset**
OFFSET control	Does not function in **Preset**

(GAMMA: Full ccw for viewing on a monitor having a conventional picture tube; full cw for a viewing device having a linear characteristic.)

3.1.1. Manual Gain Operation

When making level measurements from video, the **GAIN** switch is typically set to **Manual**. This turns off the agc circuit and activates the front panel manual **GAIN** control. Set this control fully ccw to obtain normal gain with minimum noise. Rotating the control cw increases gain, but it also brings up the noise level. This may or may not be objectionable, depending on the application. The additional gain is typically used only when low light levels are encountered.

3.1.2 Agc Operation

When the agc circuit is switched on, it has no effect if light level on the sensor faceplate is sufficient to maintain normal output. As video output drops to 90 percent, though, agc becomes active and increases gain in the camera to maintain video at 90 percent of full output. This level can be maintained for 20 dB, the range of agc. If light level on the sensor faceplate is further reduced, video output from the camera will then drop in proportion.

When agc provides additional gain, noise level in the video will increase.

Table 3-1. Operator Controls

NAME	POSITION	FUNCTION
Power switch	**On** **Off**	•Turns CCU and Camera Head internal power on •Turns CCU and Camera Head internal power off
Black switch	**Auto** **Test** **Off**	•Black levels in the scene are pulled to reference (setup) level •Provides gray scale stairstep signal in place of standard video •Black in the scene is left at its actual value and not pulled to reference (setup) level
Video Negative switch	(Up) (Down)	•Blacks and whites in the scene are reversed •Normal video provided (white positive)
Sharpness control	ccw to cw	•Clockwise rotation increases sharpness of black/white and white/black transitions in scene (full ccw for measurement applications)
Shutter switch	**Low** (1/1000 s) **Off** (1/60 s) **High** (1/2000 s)	•Sensor integrates 1 ms for each field (4 f/stops lost) •Sensor integrates 16.7 ms (normal time) for each field •Sensor integrates 0.5 ms for each field (5 f/stops lost)
GAMMA switch	**0.5 - 1.0** **1.0 - 1.5**	•Conditions **GAMMA** control to have range from 0.5 (ccw) to 1.0 (cw) •Conditions **GAMMA** control to have range from 1.0 (ccw) to 1.5 (cw)
GAMMA control	ccw to cw	•With switch above, provides gamma range from 0.5 to 1.5
GAIN Switch	**Auto** **Manual**	•Provides 20 dB automatic gain control at lower light levels •Activates manual **GAIN** control for manual control of gain
GAIN control	ccw to cw	•With switch above in **Manual**, provides manual control of an additional 20dB of gain
OFFSET switch	**Preset** **Manual**	•Deactivates **OFFSET** control. Leaves white and black areas of video in their normal relationship to setup level. •Activates **OFFSET** control. Makes it possible to shift black and gray areas of video below setup level.
OFFSET control	ccw to cw	•Rotation shifts video +5 to -85 IRE units. Shifting part of video below blanking then increasing gain with agc or manual control stretches whites to increase output. Video can be shifted down 38dB but only 20dB additional gain is available. Thus full video output may not be available. Effect of control is to look at white areas of video.

3.1.2 Shutter Operation

If stop action (strobe effect) is required to view a moving object, set the **Shutter** switch to either **Low** (1/1000 s) or **High** (1/2000 s). Operating at either of these electronic shutter speeds requires that the subject be sufficiently illuminated to make up for the brief integrating times of the sensor. This is equivalent to about four or five f/stops.

3.1.3 Offset Operation

When the **OFFSET** switch is set to **Preset**, the peak-to-peak envelope of video has its normal relationship with setup (black) level. See figure 2-2. If the switch is set to **Manual**, this envelope can be shifted up and down. With the **OFFSET** control fully ccw, the peak-to-peak envelope is shifted up about 5 IRE units from normal. When the control is rotated fully cw, the envelope is shifted down about 85 IRE units from normal.

When the video is shifted below normal in this manner, only 15 IRE units of white remain above black level.

By increasing gain of the camera (either with the **GAIN** control in **Manual** mode or with agc in **Auto** mode) the envelope is then "stretched" to increase video level.

The effect is to look at white areas of the scene, disregarding black areas.

Since the **OFFSET** control can reduce the envelope by 85 IRE units (38 dB) but only 20 dB of increased gain is available, full video output will not be available if the **OFFSET** control is fully cw.

3.2 LENS CONTROLS

Since manual lenses are typically used with this Camera, the operator must maintain control of both focus and iris at the Camera Head. These settings will depend on the nature of the scene being viewed. For example, if maximum depth of field is required, the lens iris will have to be stopped down. This required sufficient lighting on the scene to maintain full video output.

SECTION IV
CIRCUIT DESCRIPTION

CAMERA HEAD

4.1 SENSOR AND DRIVER BOARDS

The sensor board and driver board consists of the main groups described below. Functional block diagrams appear for each IC.

4.1.1 Sensor (U1)
4.1.2 Parallel Driver (U11)
4.1.3 Serial Driver (U12)
4.1.4 Three Channel Sample and Hold (U2)

The sensor IC for this monochrome Camera is based on an IC used for color applications. Color is typically generated by having red, blue, and green channels. Thus with this Camera, three channels are processed until they can be combined into a single channel at a multiplexer stages located within the Camera Control Unit (CCU).

Note that descriptions appear in order of signal flow, which may differ from the numerical order of the integrated circuits.

4.1.1 Sensor (U1) [Fig. 4-1]

The theory of operation and a functional description of the sensor integrated circuit follows.

4.1.1.1 Principles of Operation — Light from the scene in front of the lens is optically focused onto the photosensitive surface of the image sensor. A glass window bonded to the surface of the IC by an epoxy adhesive protects the sensor.

The light flux on this photosensitive surface generates electrical charges. These charges collect in the potential wells of the sensing elements.

During blanking, a burst of antiblooming clock pulses activate antiblooming gates. This prevents the spilling of charges onto neighboring elements. These gates form part of each sensor element on the chip.

Excess light-generated charges are neutralized by combining with charges of opposite polarity from the substrate.

During each vertical-sync period a field of charges moves in parallel into the storage area, then transfers a line at a time into the serial registers. They then pass to the output buffer stage.

Another field is being collected while the current field is being read out.

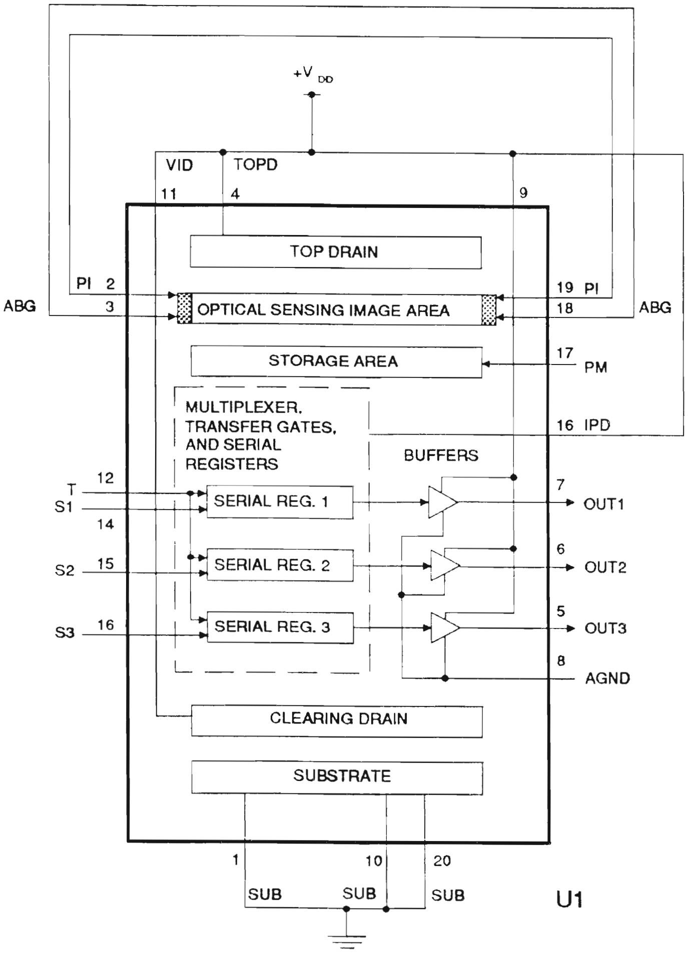


Figure 4-1. Functional Diagram, Sensor IC

4.1.1.2 Functional Description — The IC consists of four basic functional stages: image-sensing area, storage area, multiplexer (with serial registers and transfer gates), and the three buffers.

The sensor IC functional block diagram (fig. 4-1) provides a representation of the location of each of these stages within the IC.

• IMAGE SENSING AREA

The image sensing area is a photosensitive zone where electron charges are produced in response to light flux.

Delayed antiblooming gate (ABG) enters U1-18 and U1-3. This signal activates the antiblooming gates.

PI is the image area vertical dump clock. It enters the sensor IC (U1) on pins 19 and 2. This signal dumps the charge columns from the image area to the storage area.

• STORAGE AREA

The storage area is a light-protected layer. It holds the discrete charges in an array of MOS capacitors formed between electrodes and the substrate.

Input signal PM, at U1-17, moves the charge columns through the storage area to the multiplexer.

• MULTIPLEXER AND TRANSFER GATE

The multiplexer and transfer gates move charge columns a line at a time into the serial registers for readout. These gate signals enter U1 on pins 14, 15, and 16 to gate serial registers 1, 2, and 3.

Signal T gates these serial registers. Charges transfer a line at a time from the columns of charges in the storage area into the serial registers for readout.

The serial registers transfer the line of charges into the output buffer amplifiers. Here the discrete charges convert into video signals. This video leaves the IC on pins 5, 6, and 7.

4.1.2 Parallel Driver (U11) [Fig. 4-2]

The parallel driver integrated circuit (U11) provides the drive signals that move a field of char-

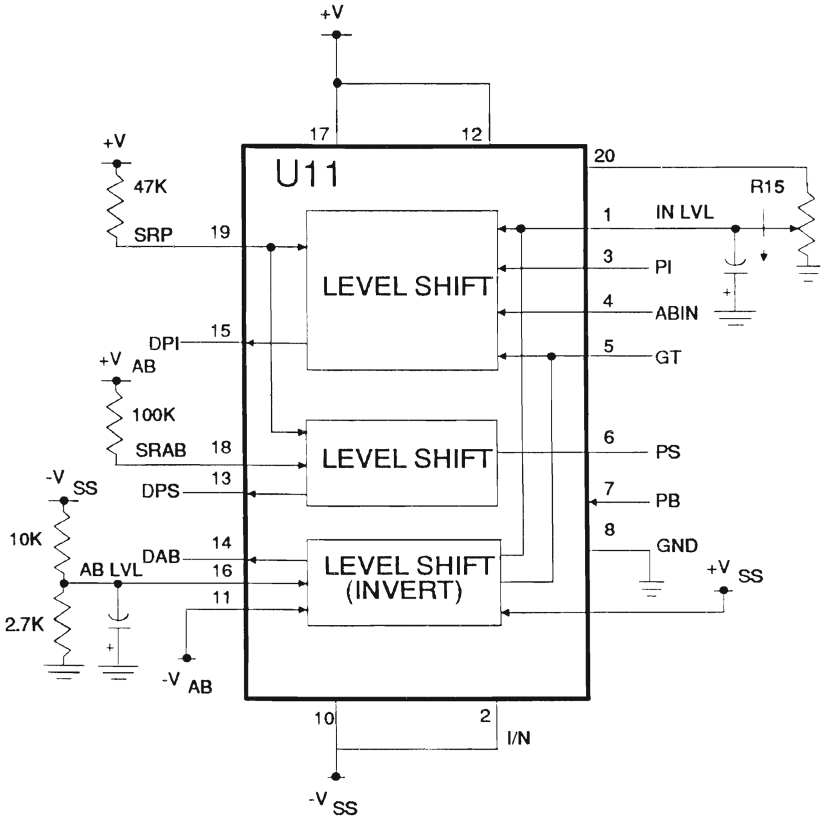


Figure 4-2. Functional Diagram, Parallel Driver IC

ges in parallel through the sensor from the image area into the storage area.

The only electrical adjustment in the Camera Head is the integration level potentiometer (R15) for the parallel driver board. Voltage from the wiper enters U11 on pin 1.

Signal GT is a command used to switch between antiblooming and normal processing modes during each transfer cycle. This signal enters U11 at pin 5 and passes to two voltage level shifters on the IC.

The image area vertical-dump clock (PI) enters U11 at pin 3, shifts in level, and exits on pin 15 (DPI).

The storage area vertical-dump clock (PS) enters U11-6 from J1-4. This signal shifts in level and exits on pin 13 (DPS).

The antiblooming clock (AB/INT) from the sync IC enters the Camera Head at J1-2. It enters U11 at pin 4.

This signal is then level shifted and delayed.

The modified signal exits U11-14 as DAB (Delayed Anti Blooming).

4.1.3 Serial Driver (U12) [Fig. 4-3]

The serial driver integrated circuit (U12) provides drive and clock signals to the three serial registers, located on the sensor. Clock signals S1, S2, and S3 enter U4 on pins 6, 5, and 4 from J1-15, -16, and -17. These signals shift in voltage level to provide gating signals DS1, DS2, and DS3, which exit the IC on pins 14, 15, and 16.

The multiplex gate clock signal (T) at U12-7 is level shifted to generate the multiplex transfer gate signal DT, which exits at U12-13.

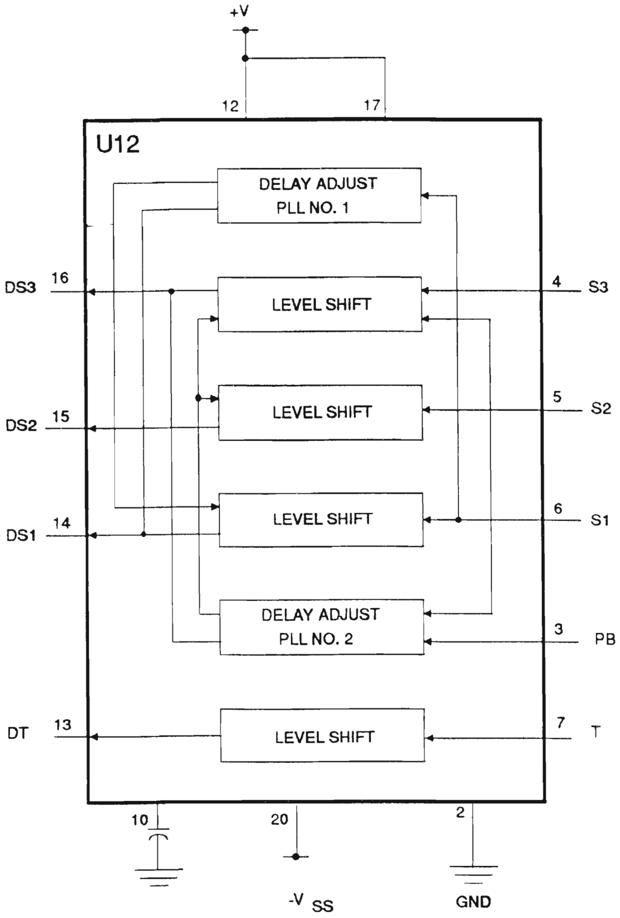


Figure 4-3. Functional Diagram, Serial Driver IC

4.1.4 Three Channel Sample and Hold (U2) [Fig. 4-4]

Integrated circuit U2 provides three channels of sample and hold. Video from the sensor IC enters U2 on pins 2, 4, and 6. This video passes to differential amplifiers in three separate channels. The channel-1 input signal on pin 2, for example, routes to the inverting input of the differential amplifier for channel 1. The noninverting input of the amplifier is ac referenced to ground. The channel-2 and channel-3 input signals are functionally identical.

The resulting inverted signal from the amplifier in each channel passes to a sample-and-hold stage.

Video signals in the sample-and-hold stages are then gated out by the 1DIN, 2DIN, and 3DIN pulses. These gating pulses enter U2 on pins 16, 15, and 14 from the sync IC (U51) on the sync/genlock board. Signals 1DIN, 2DIN, and 3DIN enter the Camera Head at J1-7, -6, and -5 as SH1, SH2, and SH3.

4.2 VIDEO DRIVERS

Three channel video output from the sample and hold IC is applied to three drivers. They supply signals to pins 11, 13, and 25 of J1 for interconnection from the Camera head to the CCU.

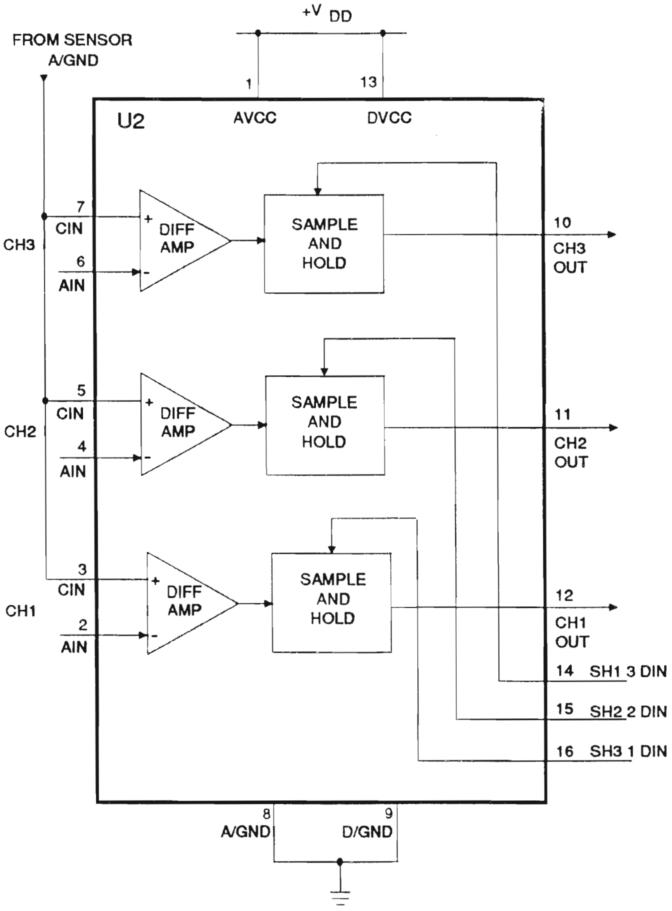


Figure 4-4. Functional Diagram, Three-Channel Sample and Hold IC

4.3 CAMERA HEAD TO CCU INTERCONNECTIONS

All connections between Camera Head circuits and CCU occur through a single cable. Table 5-7, in the Maintenance Section, lists each pin and gives its name and function.

This cable provides circuits in the Camera Head with operating voltages and sync timing waveforms from the CCU.

Passing back to the CCU are three channels of video from the Camera Head.

CAMERA CONTROL UNIT

VIDEO/AUTO/POWER SUPPLY BOARD

4.4 VIDEO/AUTO/P.S. BOARD

Figure 4-5 illustrates the schematic diagram locations on figure 7-3 for the major circuit groups on this board. Figure 4-6 is an overall functional block diagram of the board video signal path. This block diagram and the functional descriptions accompanying it (section 4.4.1 through 4.4.8) are intended as a general overview of the video signal path.

Sections 4.5 through 4.17 and their related functional diagrams will expand on these and other circuits on the video/auto/P.S. board.

4.4.1 Three-Channel Amplifier

Three channels of video are received from the camera head (fig. 4-6). One channel is used as a reference. The other two channels are then adjusted so that their gains and black levels are identical to this reference channel. Two white balance and two black balance potentiometers set these levels.

4.4.2 Multiplexer

A single channel of video is produced by gating on, in turn, each of the three switches (U2). Gate 1, gate 2, and gate 3 turn the switches on and off.

4.4.3 Filter

The lowpass filter rolls off sharply above the video bandpass to eliminate clocking signals. This is a three-pole filter.

4.4.4 Offset

The offset circuit makes it possible to shift the video envelope up 5 IRE units and down 85 units relative to blanking reference level. The front panel **OFFSET** control performs this action when the related **Preset / Manual** switch is in the **Manual** position. When the switch is in the **Preset** position, the video envelope is established in its normal relationship with blanking. Black video peaks are then 7.5 IRE units above blanking level. (See figure 2-2.)

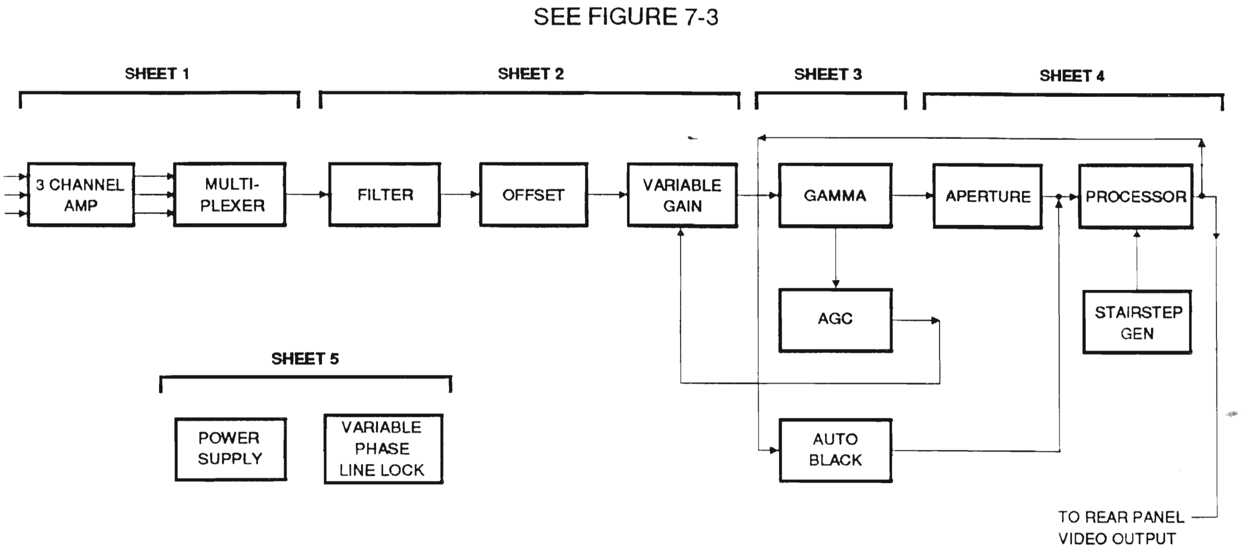


Figure 4-5. Schematic Diagram Locations, Video/Auto/P.S. Board Circuits

4.4.5 Variable Gain

Video gain can be controlled either by the agc circuit or by a front panel **GAIN** control. A front panel **GAIN** switch selects either **Auto** or **Manual.** Note that agc gain is controlled by a peak-average potentiometer (R103) and an agc level potentiometer (R106). The peak average setting depends on the type of scene the camera is to view. If the scene typically contains a large portion of bright highlights, set this potentiometer to favor the white peaks. If the typical scene has even contrast with few highlights, set it to an average setting.

4.4.6 Gamma

Gamma is a function defined by $y = x^g$. Gamma of 1.0 is a linear video response. Gamma of 0.5 gives additional gain to black levels. Gamma of 1.5 gives additional gain to white levels.

A front panel **GAMMA** switch and control makes it possible to set gamma in two ranges from 0.5 to 1.0 and from 1.0 to 1.5. The potentiometer combines the gamma selected with a direct video signal path to produce the desired gamma.

4.4.7 Aperture

The aperture circuit makes it possible to increase the slope of black/white and white/black transitions. With the slope steeper, black and white edges are better defined, giving a better appearance on a picture monitor.

Areas in a scene requiring a sudden change from white to black (or black to white) produce high frequencies in the video. (Areas of gradual change produce lower frequencies.)

The aperture stage makes use of the fact that sudden transitions between black and white are high frequencies. It provides an alternate signal path that reacts to these high frequencies. That signal path is a delay line which does not have its input end terminated with its characteristic impedance. Being unterminated, the delay line produces a reflected wave at the high frequencies representing white-black (black-white) transitions.

The **Sharpness** potentiometer then is used to mix in this high frequency video with video in the normal video signal path. This gives control of the amount of sharpness added to the video.

This front panel control should typically be fully ccw for measurement applications.

Following this sharpness portion of the aperture circuit is a switch controlled from the front panel of the CCU (**Video Negative**). This switch changes between normal (white positive) video and reversed video (black positive). Note that in reverse video

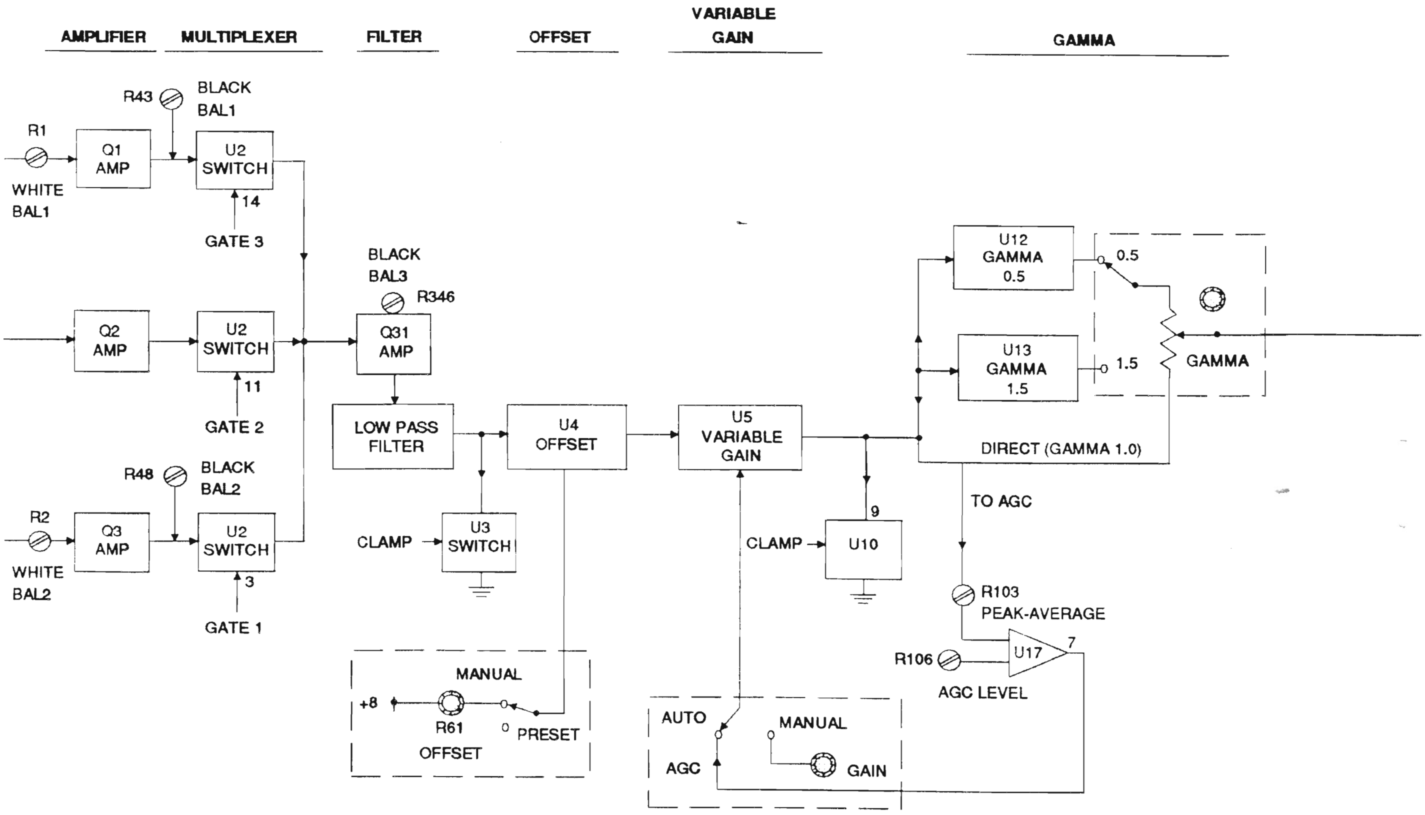


Figure 4-6. Functional Diagram, Video Signal Path

mode, a reverse setup potentiometer (R131) is switched into the circuit. This potentiometer is in addition to the regular setup potentiometer (R152), which is left in the video signal path.

4.4.8 Processor

Processor circuits have the following basic functions:

1. Provide either video or stairstep
2. Provide stairstep number and level controls
3. Provide loop point for auto black feedback and control
4. Provide setup adjustment
5. Provide white clip adjustment
6. Provides sync adder at output stage

A three-position front panel switch selects either auto black on, auto black off, or test. The **Test** position of the switch turns off the normal video signal and in its place provides a stairstep signal. The number of stairsteps and their video level are internally set by potentiometers R309 and R324.

When automatic control of black level (auto black) is selected by the front panel switch, a feedback loop is initiated. It monitors video level at the output of U15-6 and supplies it to the auto black circuit (section 4.14 and figures 4-14, 4-15, and 4-16). The auto black circuit uses the black level reference set by the auto black potentiometer (R184). It provides a feedback black level to Q141, which is connected to the video signal path. The clamp pulse turns this transistor switch on during horizontal

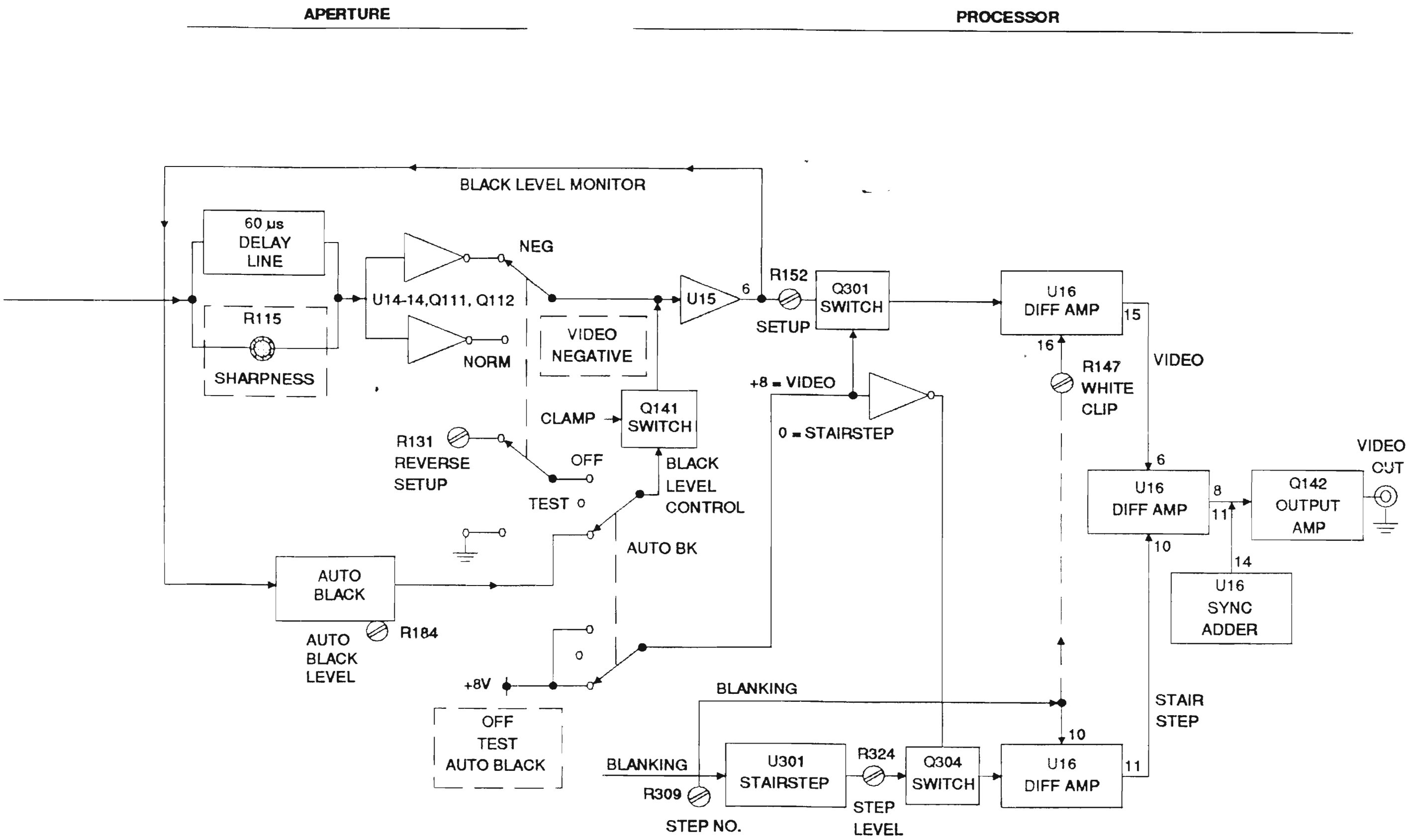


Figure 4-6. (Continued)

(line) blanking intervals. Black level correction is applied to video during blanking for each line. (Lines near V. blanking are not used.)

Setup adjustment is provided by R152. This is typically set for 7.5 IRE units (53 mV) above blanking level.

White clip limits the video white peaks to the maximum level set by this potentiometer (R147). This is typically set for 110 IRE units, but other levels can be used. The blanking waveform acts as a signal source for the white clip circuit—not as blanking at this point in video. It is just a design convenience to use the blanking waveform in this manner.

The sync adder (U16-14) and video output stage (Q142) are the last two stages in the video signal path. The video output BNC connector shown in the figure is the CCU rear panel video output connector. This output is a 75-ohm composite video output.

4.5 AMPLIFIER

4.5.1 Three-Channel Video Stages (Fig. 4-7)

Three separate video inputs are received from the sensor. Only one channel is shown in the functional diagram. The other two are functionally identical—except that channel 2 acts as a reference channel and thus does not require two adjustable

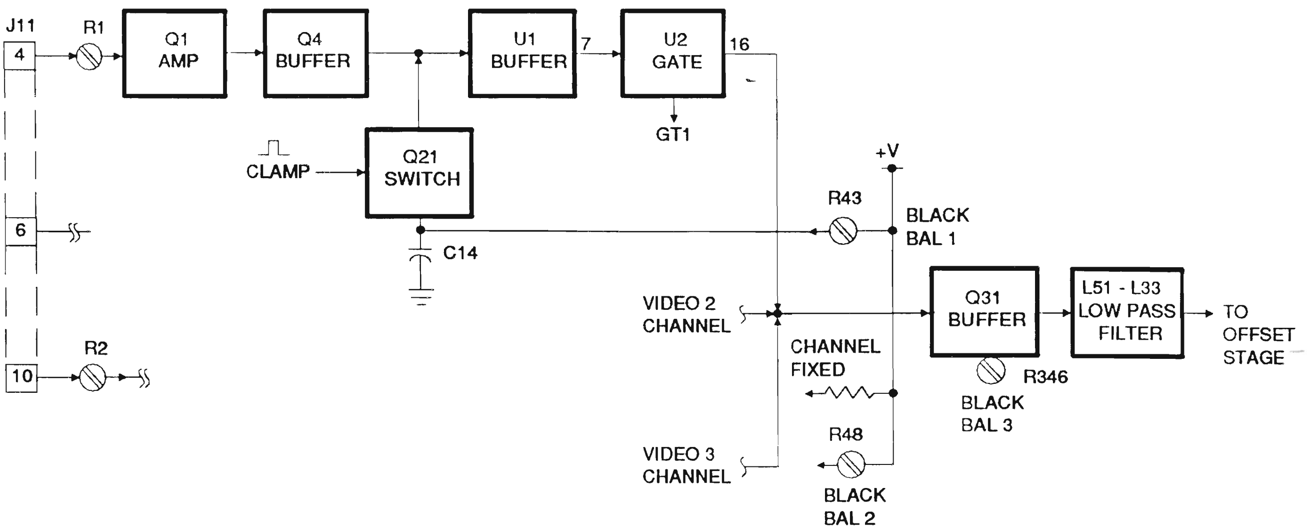


Figure 4-7. Functional Diagram, 3-Channel Video Stage

potentiometers appearing in channels 1 and 3. Channel 2 lacks a gain control potentiometer and a black level reference potentiometer. Channels 1 and 3 are adjusted to the levels of channel 2.

The channel-1 video gain is set by R1. Gain is made identical to that of the reference channel.

The channel-1 black level is set by R43. Black level in this channel is made identical to that of the reference channel. This is done by pulling the video line to reference black level during the horizontal-blanking pulse interval. The clamp pulse switches on Q21, connecting the video line to capacitor C14. This capacitor maintains a charge identical to that for black level on channel 2, the reference. So the channel-1 video line is pulled to reference black level once for each horizontal line.

4.6 MULTIPLEXER

Because the sensor produces three channels of video, one after the other, the video signal paths must be turned on and off in the same sequence. Thus the gate, U2, receives a turn-on pulse one-third of the time so it can pass through video from the sensor.

4.7 FILTER

Video from the three channels couples through a low-pass filter and routes to the agc stage.

4.8 OFFSET

Refer to figure 4-8. The **OFFSET** potentiometer (R61) is a front panel control. It shifts the video envelope up 5 IRE units or down 85 units. When shifted down, the black and dark gray areas of the video envelope are moved into blanking. Only the portion of the video remaining above blanking is then available as the video signal.

The **OFFSET** potentiometer biases the operational amplifier (U4) negative input between +8 and

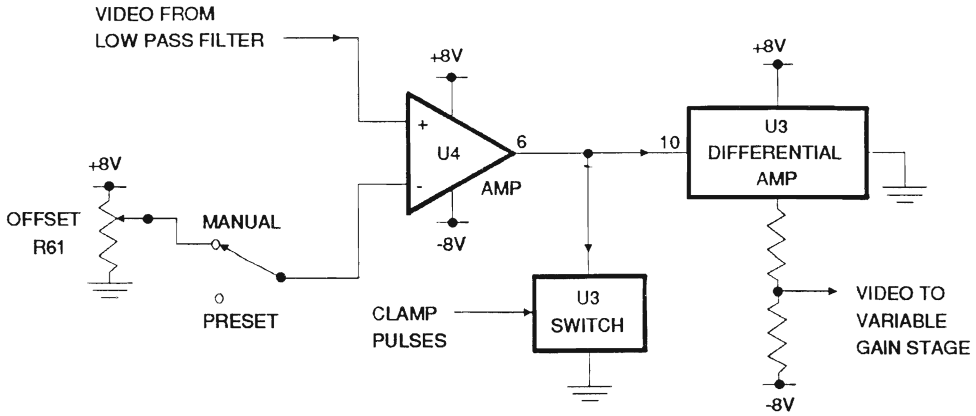


Figure 4-8. Functional Diagram, Offset Stage

ground, thus shifting the video envelope up and down.

Output from U4 is pulled to ground during each horizontal blanking interval by the clamp pulse applied to switch U3. This maintains a ground reference for the video envelope.

Video passes through the differential amplifier (U3) to the next stage, variable gain.

4.9 VARIABLE GAIN (U5)

See figure 4-9. The agc IC (U5) consists of a gain control stage and an output buffer. Pin 6 is tied to a fixed reference input. Pin 4 receives either manual gain control input or agc input. Both provide 20 dB control. This is additional gain for the camera. When this gain is used, some additional noise is introduced into the video. The signal-to-noise ratio listed in the specifications of table 1-1 will be reduced somewhat.

Video from the variable gain stage passes to the gamma stage.

4.10 GAMMA

(See section 4.10.1 for a brief review of gamma correction as originally used in tv cameras.)

Following the agc stage is the gamma correction stage (fig. 4-10). Gamma correction is a modification of the camera video response: ($y=x^g$, where g is in the range 0.5 to 1.5). A gamma of 0.5 provides increased gain for black areas of the video scene. A gamma of 1.5 favors white areas. A gamma of 1.0 is normal, linear video.

The Gamma stage has two circuits. One produces video with gamma of 0.5, the other produces video with gamma of 1.5. The front panel **GAMMA** switch selects either of these gamma modified video signals. The related front panel control is then adjusted to combine gamma video with normal, linear video. This makes it possible to produce any gamma in the range 0.5 to 1.0 or 1.0 to 1.5.

4.10.1 Background of Gamma

Gamma correction was originally created to compensate for the characteristic of vacuum tube type picture tubes used in tv sets. These tv picture tubes are nonlinear near cutoff (gain drops). To keep the picture tube response linear in relation to the Camera, the control grid of the picture tube must receive additional signal as it approaches cut off (black level). Instead of making this compensation at each tv set, it was decided in the early years of television to do it at the Camera. When camera gamma correction is set to 0.5, video signal level approaching black level is greater than it is for gray and white video. This amount of additional signal

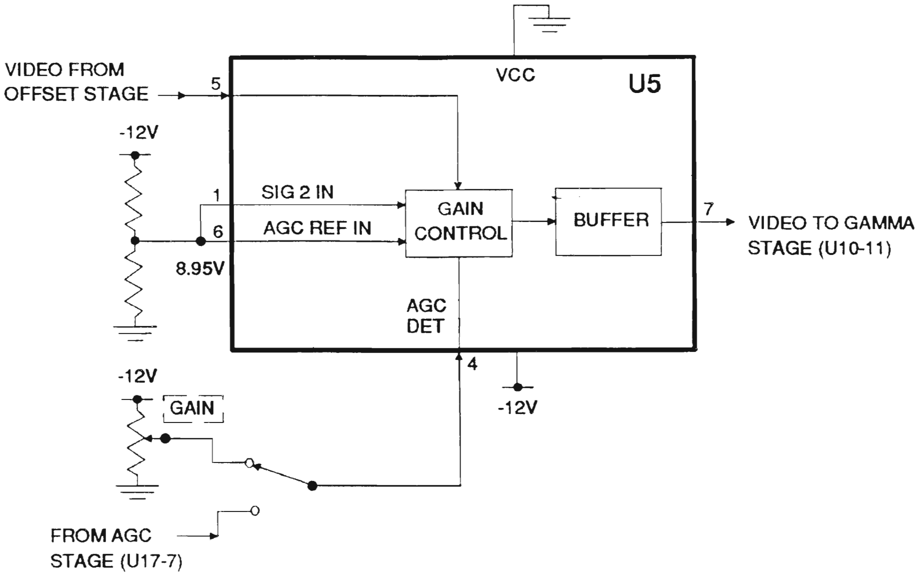


Figure 4-9. Functional Diagram, Variable Gain Stage

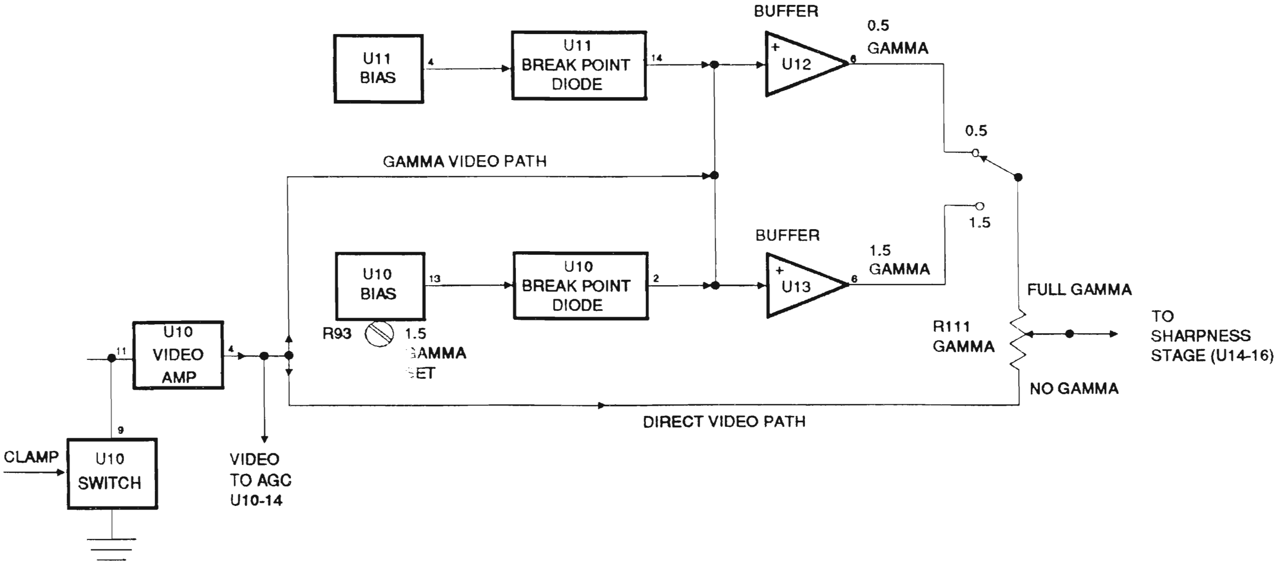


Figure 4-10. Functional Diagram, Gamma Stage

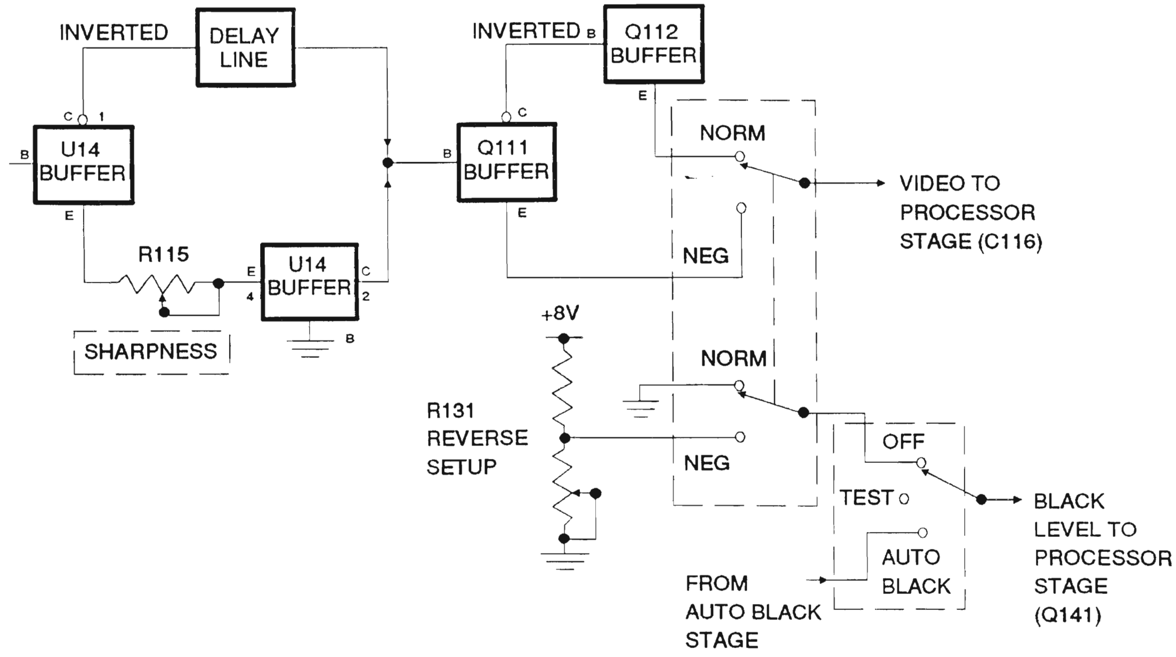


Figure 4-11. Functional Diagram, Aperture Stage

for blacks effectively makes the picture tube linear near cutoff.

4.11 APERTURE

Refer to figure 4-11. The aperture stage has two signal paths. The path through the **SHARPNESS** control (R115) is linear, unmodified video. The path through the delay line, however, produces a steep slope with overshoot on white-black and black-white (high frequency) transitions.

The front panel **SHARPNESS** control can combine the two video signal paths to provide up to 6-dB overshoot at 6 MHz. This increases the high frequency video slopes to give a crisper image to white-black and black-white edges on the tv monitor.

The delay line produces a steep slope for high frequency (6-MHz) video because its input is not terminated into its characteristic impedance. This sets up a standing wave near 6 MHz that produces steep edges on black-white and white-black transitions.

4.11.1 Normal-Negative Video

The video envelope can be inverted so that white peaks are positioned at setup and black peaks 100 units above that. To do this two video outputs are taken from transistor Q111, which is driven on its base. The collector output is inverted video, the emitter output is not. The front panel **Video Negative** switch, then, selects either normal or negative video.

Note that when the video envelope is inverted, it must be shifted back into proper reference with blanking. The Reverse setup potentiometer (R131) does this.

4.12 STAIRSTEP GENERATOR

Refer to figure 4-12. The stairstep generator is turned on when the front panel **Auto Black** switch is placed in the **Test** (center) position. The video signal path is turned off when the stairstep generator is activated.

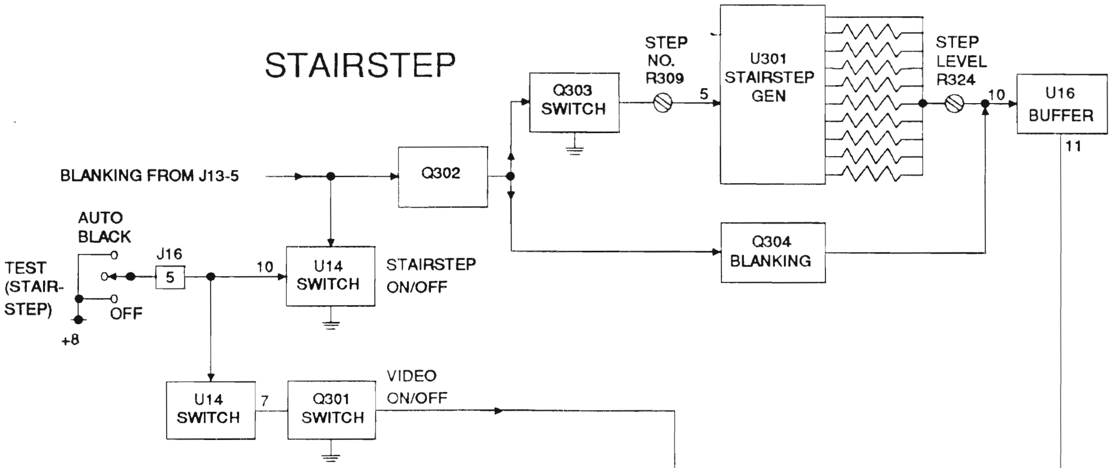


Figure 4-12. Functional Diagram, Stairstep Stage

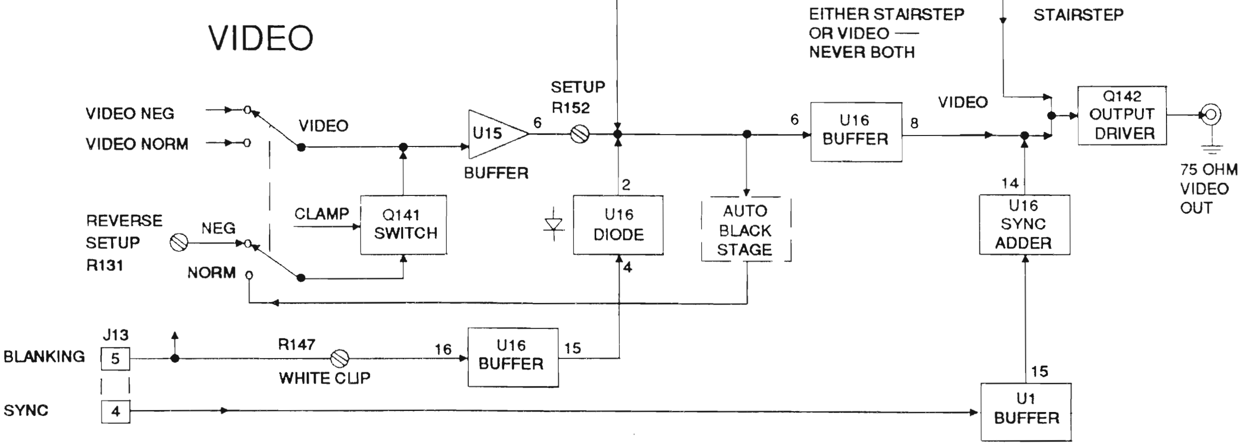


Figure 4-13. Functional Diagram, Video Processor Stage

With the switch in **Test**, J16-5 floats. Switch U14-10 turns off, releasing the input of Q302 from ground. Blanking is then able to pass through Q303 to trigger the stairstep generator (U301) at the horizontal rate.

It produces 10 outputs. The output resistors establish a stepped increase in signal level to produce the stairstep. Step level potentiometer (R324) is set to provide 100 IRE units of peak-to-peak video at the 75-ohm video output of the CCU. Blanking is applied to the stairstep output following the level potentiometer.

4.13 PROCESSOR

4.13.2 Video Processor Stage

Refer to figure 4-13. This is the last stage before video is applied to the rear panel 75-ohm output, BNC connector J1.

This video stage is turned off (pulled to ground) when the stairstep test signal is turned on. With the front panel switch in **Test**, U14-7 (fig. 4-12) is turned on, which then turns on Q301 to pull the video signal path to ground.

The processor stage can receive either normal white positive video or inverted video, depending on the position of the front panel **Video Negative** switch.

If Negative video has been selected, the Reverse Setup potentiometer (R131) shifts the video envelope into proper relationship with blanking. That is, it is positioned so that the white peaks are just above blanking (and thus black peaks are at about 100 units.)

Voltage from the Reverse setup potentiometer is applied through Q141, which is turned on at the horizontal rate by the clamp pulse occurring during blanking intervals.

If normal video (white positive) is selected, this clamp transistor applies auto black voltage to maintain the video signal path at 7.5 IRE units above blanking.

Video out of U15-6 is set for 7.5 IRE units by R152. This is also the point where the auto black circuit monitors the video black level to maintain the 7.5 units. Auto black develops the required correction and couples it back to transistor Q141, which then applies the correction when turned on by the clamp pulses. These occur during the blanking intervals for horizontal lines.

Blanking is added to the video signal path at U16-6.

Just before video is sent out to the rear panel BNC connector, U16-14 adds sync to it.

4.14 AUTO BLACK

The auto black circuit group essentially contains a window generator, a black peak detector, and an integrator. This window opens only during active video lines. The peak detector then uses black areas of video on each line to produce a voltage related to black level. The integrator generates a correction voltage which is coupled back to the video signal path, thereby automatically maintaining proper black level. If the CCU front panel **Auto Black** switch is in **Off** or **Test**, this automatic circuit does not function.

4.14.1 Window Generator (Fig. 4-14)

Refer to figure 4-14 for a functional diagram of the window generator circuit. The window generator turns on the black level control circuit. It must be turned on only during active video times of the sensor. That is, the circuit must not "see" any vertical blanking or horizontal blanking (neither at top and bottom nor left and right).

To ensure this vertically, the automatic control circuit is gated on after blanking at the top and then off again before blanking begins at the bottom.

To ensure this on horizontal lines, the circuit is gated on only after a line has started and then off again just before the line ends. This is done for each line down the field.

The Auto circuit is turned on when U18-14 (fig. 4-15) is low and off when it is high. This is implemented by the two U19 one-shot stages (fig. 4-14) operating under control of vertical-gate (window) pulses and clamp pulses.

A vertical-gate pulse occurs for each vertical-blanking pulse. The gate pulse starts before the blanking pulse and ends after it.

A clamp pulse occurs for each horizontal-blanking pulse. The clamp pulse begins and ends within the period of the horizontal-blanking pulse.

The vertical-gate pulse goes high just after vertical blanking ends and low again just before it begins. This high state during active video of vertical is used as an enable for the two one-shots.

The first one-shot is triggered by the clamp pulse. A narrow clamp pulse occurs for each horizontal-blanking pulse—and within its time period. After 4.3 µs the first one-shot times out. Its

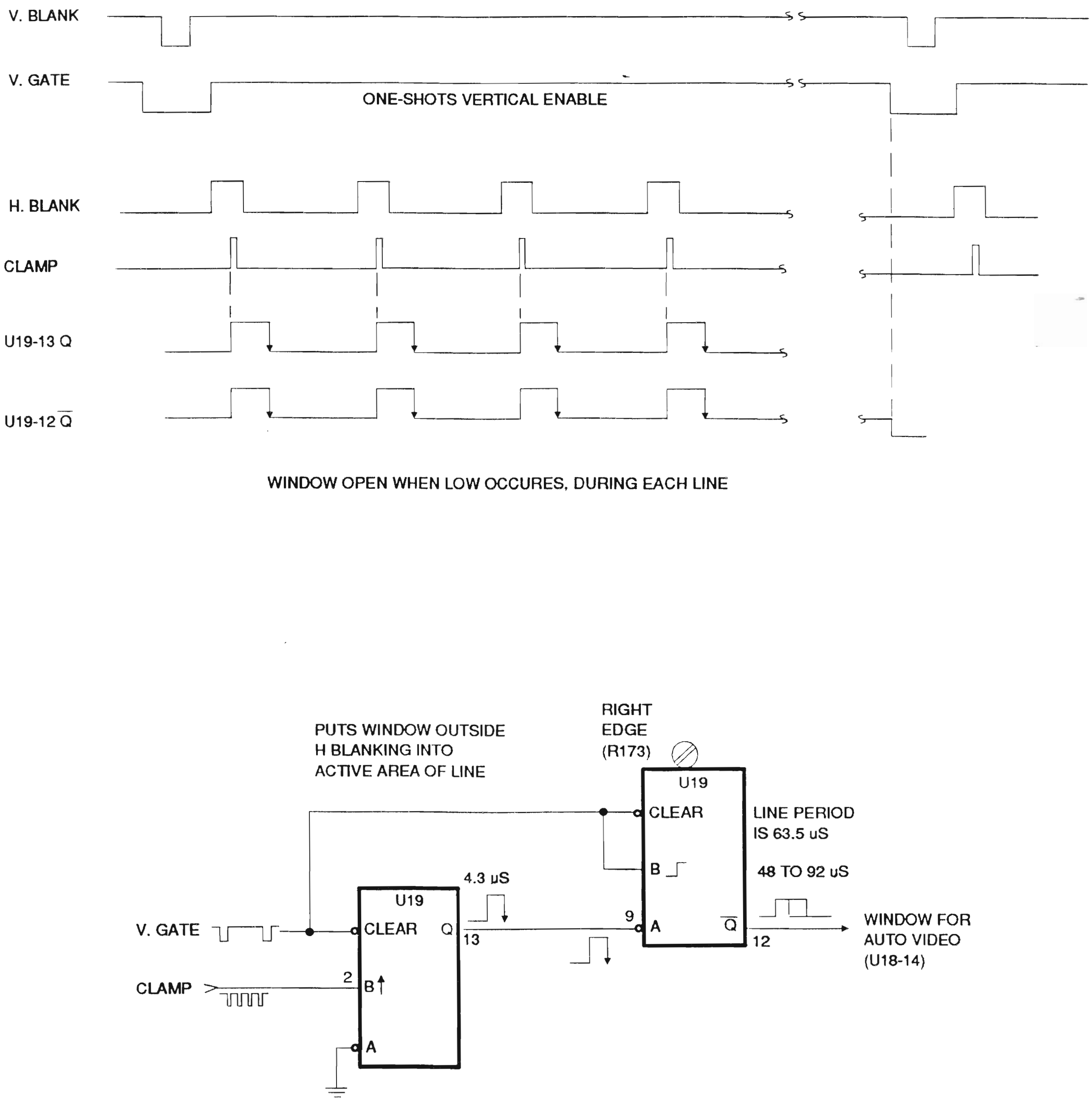


Figure 4-14. Functional Diagram, Window Generator Stage

Q output goes low. This is after the horizontal-blanking pulse ends, into the active line area.

The second one-shot triggers on the falling edge from Q. Its not-Q output (U19-12) goes low, and the window gate is opened so the automatic circuits can function. Timeout of this second one-shot is set by the Right Edge potentiometer (R173) so that not Q goes low again just before the line ends.

This continues for each clamp pulse down the field until the vertical-gate pulse goes low just before vertical blanking. This disables both one-shots. The window is closed until after the vertical-blanking interval, at which time the vertical gate goes high again.

When the gate goes high, both one-shots are enabled.

Clamp pulses applied to U19-2 can again trigger its output, and the window is open again vertically for another field of horizontal lines.

4.14.2 Auto Black

To provide automatic control of black level in the video signal path, a dc voltage must be developed from the black areas present in a scene. This voltage is used by the auto black stage to produce a feedback black level to the video signal path. Figure 4-15 is a functional overview of the auto black circuit.

For greatest accuracy, the stage that is tracking black levels present throughout a scene (or changing scenes) must have a short time constant so that it can follow peaks as well as larger areas of black. Output from this stage is then averaged. Selection of time constants and integration period provide a smooth dc voltage related to the black levels present throughout the changing scenes.

This detector is gated so that it only acts on video present during the active horizontal-scan lines during each field.

Active transistors are connected in a dynamic circuit with negative feedback so that the black peaks can be followed for a most accurate representation of the black level.

Figure 4-16 is a functional representation of the black detector stage. This stage is off during all blanking. In fact, the black detector gets gated on only after a horizontal line has started and then is turned off before it ends. It also does not turn on until after lines have started at the top of a field and is turned off before they end at the bottom. Thus, some lines before and after vertical blanking are skipped.

The black peak detector is turned off near the edges of blanking because the pixels on a sensor IC end very near blanking. Any slight error could cause a false black level. So the window ensures that any black fringes are not seen by the black detector.

Auto video is applied through U18-14 to a differential amplifier. This stage is turned on only

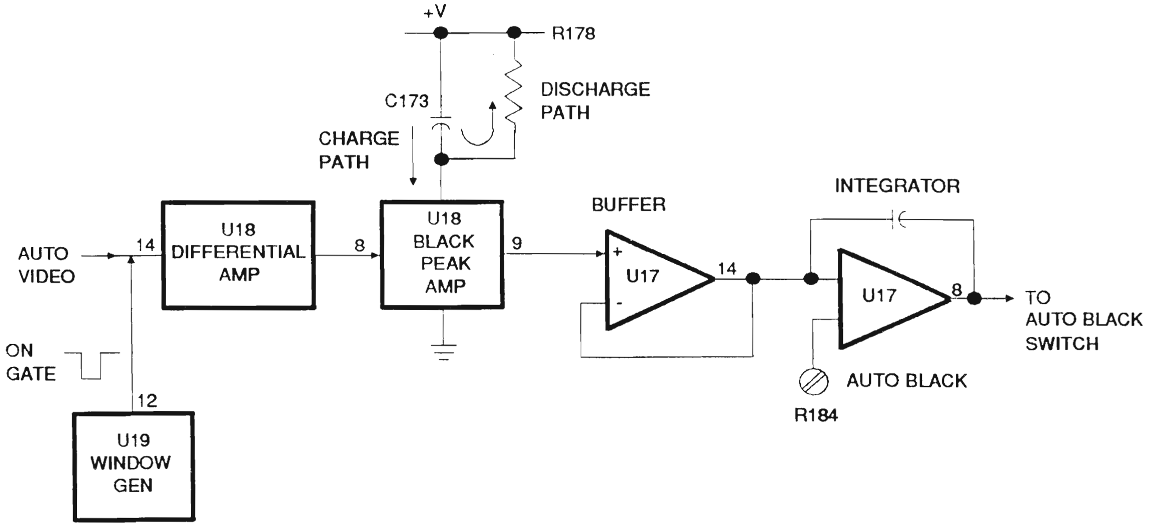


Figure 4-15. Functional Diagram, Auto Black Stage

when it receives a low-state gating pulse on pin 14 (base) of the transistor.

This pulse is provided by the window generator stage (section 4.14.1). It goes low after a horizontal line has started and high again before the line is blanked.

Negative peaks (or level) on video passing through the differential amplifier cause the black-peak amplifier to increase conduction. This charges capacitor C173. When the black peak amplifier has white level as input, it turns off and becomes a high impedance. In effect it drops out of the circuit. The only significant discharge path for the capacitor is through resistor R178. Thus the capacitor is charged to the blackest portions of a scene by the black peak amplifier, but discharged only by the resistor. The dc voltage on this capacitor is integrated and applied to the integrator (U17-8), which then uses it to maintain black level in the video signal path.

4.14.3 Gated Dynamic Black Detector (Fig. 4-16)

Figure 4-16 is a detailed partial schematic diagram of the black detector stage. Figure 7-3 sheet 3 shows the complete schematic diagram for this stage.

Refer to the previous overall functional description, in section 4.14.2, for an overview of this stage.

The differential amplifier has a current source (high impedance) is the left leg. The transistor that is wired as a diode serves as a collector load.

When the window generator provides a low-state gate pulse to U18-14, the differential amplifier turns on. The simplified schematic shows black peak signals on inputs and outputs of transistor elements.

With negative-going voltage on pin 14, the transistor increases conduction. Increased voltage drop across R177 pulls the emitter of the right transistor away from its base and thus increases its conduction in proportion to the left leg turning on.

Pin 8 (base) of the transistor that is in series with capacitor C173 receives an increasing positive voltage, turns on, and charges the capacitor. This voltage is coupled back to pin 11 (base) of the differential amplifier. The voltage attempts to turn it off. This negative feedback lowers impedance of the

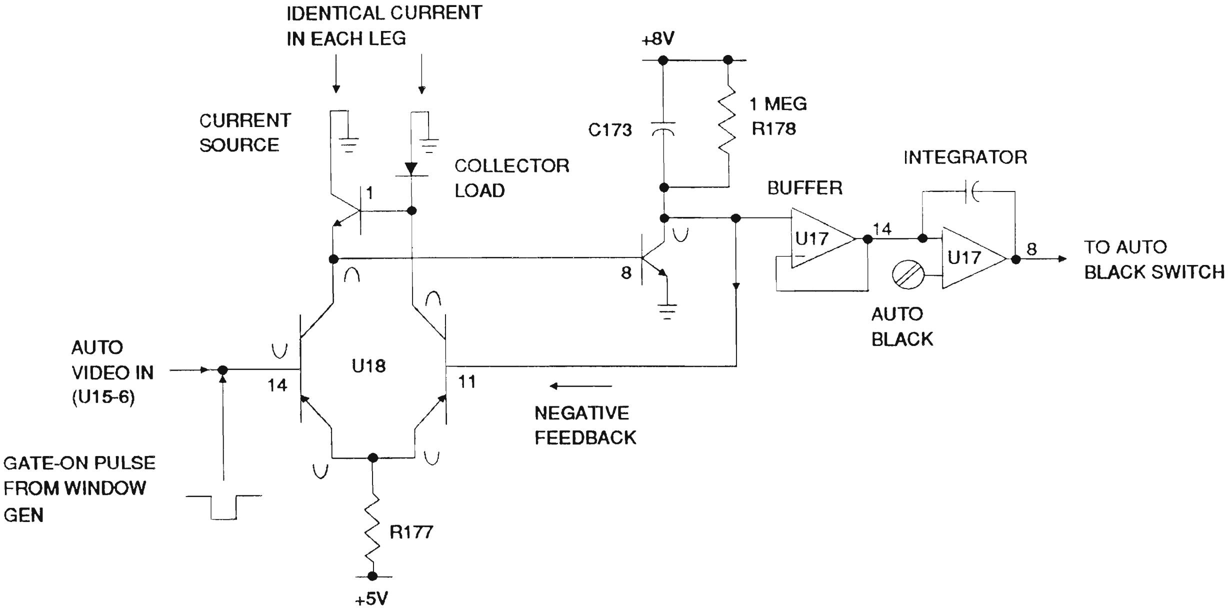


Figure 4-16. Functional Diagram, Black Detector Stage

circuit and reduces its time constant. Thus the stage is better able to respond to black peaks.

When video into the differential amplifier (pin 14) moves toward white level, the transistor (pin 8) in the capacitor charge path turns off and effectively drops out of the circuit. The capacitor is left to discharge through the resistor (R178).

The buffer presents a high impedance to the capacitor and thus has minimal discharge effect. The integrator evens out black-level voltage from the capacitor and provides a clean reference level to the video signal path.

This black level feedback correction is applied to the video signal path only during the horizontal blanking period. This occurs in the processor stage.

4.15 AGC

Refer to figure 4-17. This agc stage produces a dc voltage proportional to the level of the video signal.

Video is tapped off the signal path by buffer U10-14. Its output is rectified by the U10 diode. Positive dc voltage is developed by the rectifier and RC circuit. Time constant of the agc stage is set by the peak-average potentiometer (R103), an internal adjustment on the board. If this adjustment is set for a short time constant, the agc responds more to video peaks. Set for a longer time constant, the agc responds more to the average lighting of the overall scene.

The setting of this adjustment is dependent upon the type of scenes to be viewed and often must be determined by experience.

4.16 POWER SUPPLY

Refer to figure 4-18. Circuits in the power supply stage produce operating voltages for the Camera.

Input from the CCU rear panel is 115 V ac, ±10%. This voltage is applied to transformer T201. It steps the voltage down for the bridge rectifier.

The bridge rectifier produces B+ and B- voltages. Regulator ICs then produce the various regulated voltages required by the camera. Several of these regulator ICs have adjustments to set their outputs.

4.17 VARIABLE PHASE

Camera sync reference can be locked to the ac power line. The variable phase stage allows this ref-

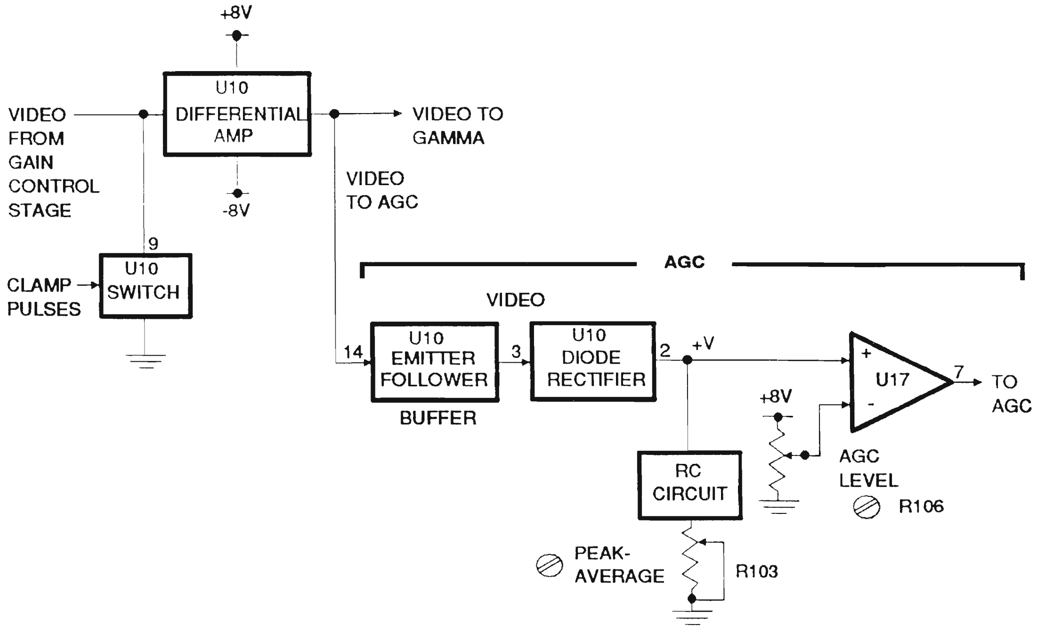


Figure 4-17. Functional Diagram, Agc Stage

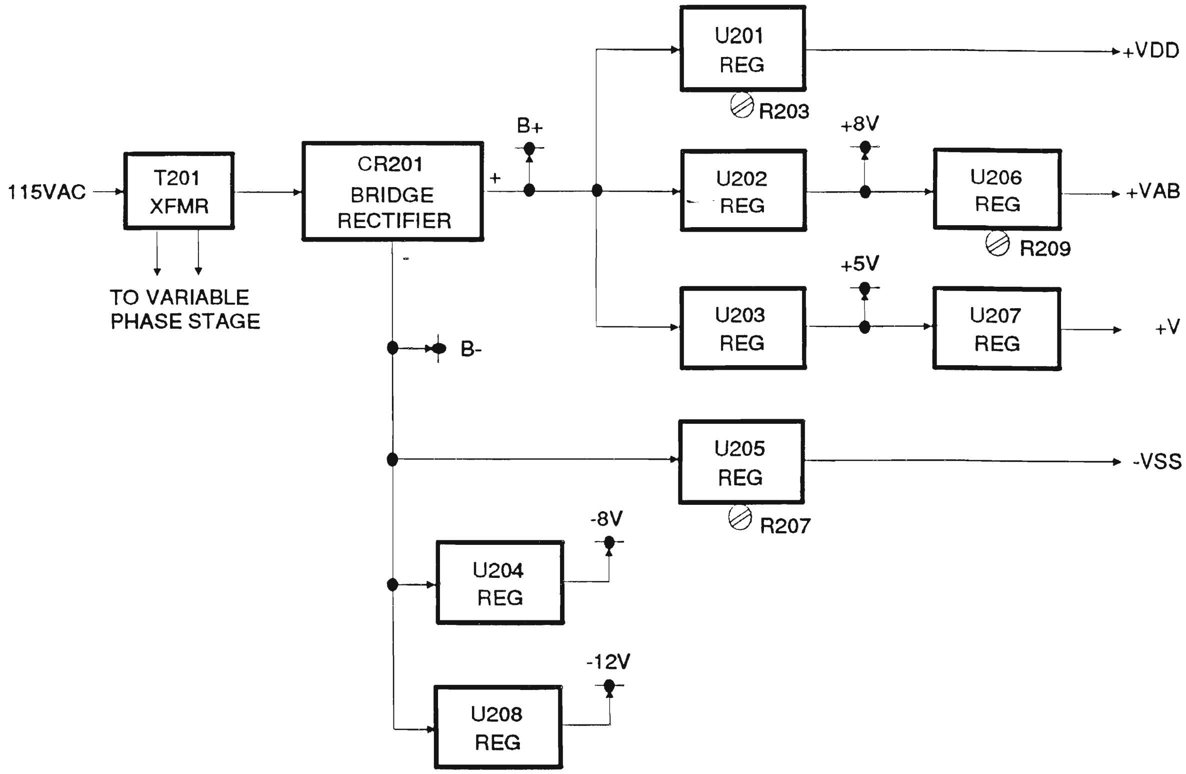


Figure 4-18. Functional Diagram, Power Supply Stage

erence to be shifted in 60 degree increments from 0 through 300 degrees.

4.17.1 Phase Adjust Line Lock

When line lock is used with multiple Cameras in a system, some of the Cameras may be operating from different phases of the ac power line. This places their vertical intervals out of phase with each other by some increment of 60 degrees.

To compensate for this, each Camera has a line-lock circuit with repositionable jumpers. These jumpers can be positioned to establish in 60-degree increments the required phase reference related to the ac line.

One Camera is selected as the reference. All Cameras operating from other phases then have their jumpers changed, as necessary, so all vertical intervals occur at the same time. This can be done by comparing vertical sync with a dual-channel oscilloscope. Video from multiple Cameras is usually available at the video switcher—which is typically used in multi-camera systems.

Refer to figure 4-19 for a functional diagram of the step-phase line lock circuit. The circuit receives 27 V ac from the power transformer secondary. This is squared up by a Schmidt-trigger input on the operational amplifier and the differentiator at the input to the 555 timer.

Zero- or 180-degree phase is established by positioning a jumper to select one of the two ac input lines. (Their relationship to each other is 0 and 180 degrees.)

Then sixty-degree steps are made by changing the RC time constant of the 555 timer (U222). Timer phase can be calibrated with the phase trim potentiometer (R228).

Using the 0 and 180 jumper together with the 60-degree jumper gives step-phase settings from 0 to 300 degrees (360 degrees is same as 0 degrees).

Timer output is squared up by the Schmidt-trigger input of operational amplifier U221-7 and then

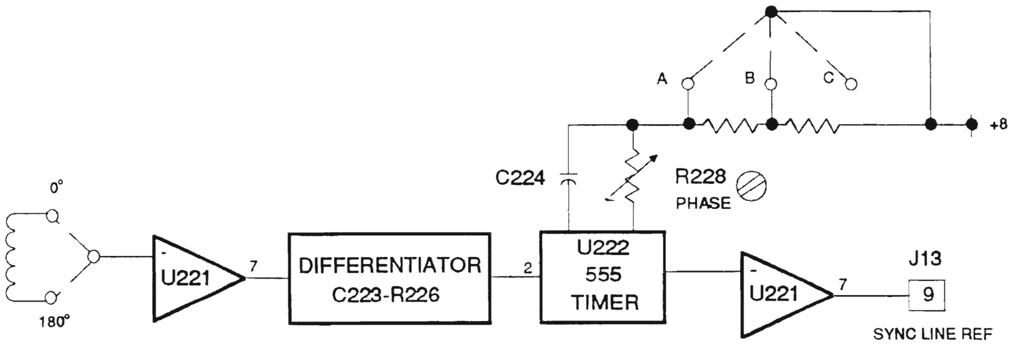


Figure 4-19. Functional Diagram, Step Phase Line Lock Stage

sent to J13-9. From there it goes to the genlock circuit where it is available as a line-lock sync reference.

SYNC/GENLOCK BOARD

4.18 GENLOCK BOARD OVERVIEW

Sync circuits can be divided into two major groups: (1) Sync reference stages and (2) Waveform generator stages (primarily sync IC U51).

Section 4.19 describe the circuits providing a reference to the sync IC.

Section 4.20 describes the sync IC outputs. All sync, blanking, clamp and other waveforms are internally generated by this IC.

4.19 GENLOCK

A sync\genlock board has six possible reference sources. They are listed below.

The first two are default operating modes. A repositionable jumper on the sync board selects which of the two is the active default mode:

1. Crystal Oscillator
2. 60-Hz Power Line

Any the following four external-input modes can "capture" sync reference from the default mode:

3. Composite Video
4. Composite Sync
5. Horizontal and Vertical trigger
6. Horizontal Trigger only (not an operating mode)

If any external input reference except vertical trigger is removed, the genlock stage reverts to its default mode, crystal or the ac power line (line lock).

Horizontal trigger without vertical trigger is not a typical operating mode. The vertical interval would not be in phase—unless it previously had been established by vertical-trigger pulses.

4.19.1 Overall Functional Operation

Figure 4-20 shows four basic methods of providing a reference signal to the sync IC (U51).

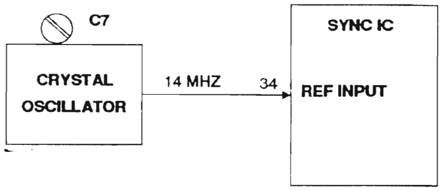
At A is the basic crystal oscillator reference. Diagrams B, and C are methods of sync reference available only with external signal inputs.

Diagram B illustrates composite video or composite sync as a reference. This method requires a single input line (1L) to the Camera. The sync separator removes video from a composite video input. The phase locked loop (PLL) compares the reference input to the horizontal gate (H. gate) signal originating in the sync IC (U51). If H. gate is not exactly in-phase (and thus exactly on frequency) with the reference signal, the PLL changes frequency of the LC oscillator so its two inputs are locked together.

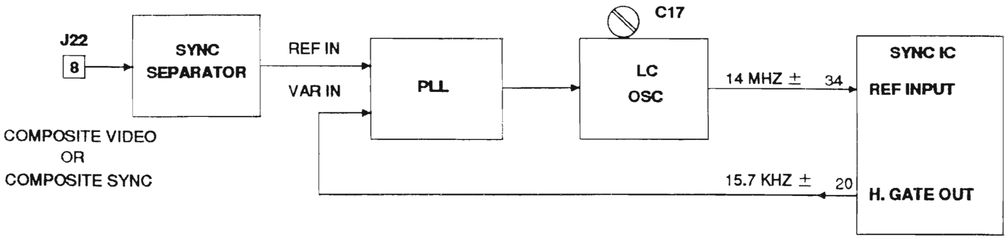
Diagram C shows horizontal trigger and vertical trigger inputs. Operation of the PLL circuit is identical to that described for diagram B. In this case, though, the vertical trigger input can be used to reset the sync IC. This method of sync reference is typically used in scientific or other special applications.

Diagram D shows sync reference derived from the ac power line. This method references camera sync to the ac power line, which is applied to the rear panel line cord. Note that the PLL is comparing

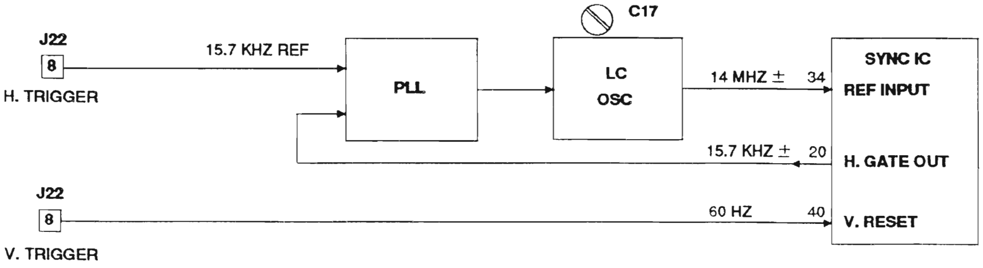
A. CRYSTAL OSCILLATOR REFERENCE



B. COMPOSITE VIDEO OR COMPOSITE SYNC REFERENCE



C. H AND V TRIGGER REFERENCE



D. LINE LOCK REFERENCE

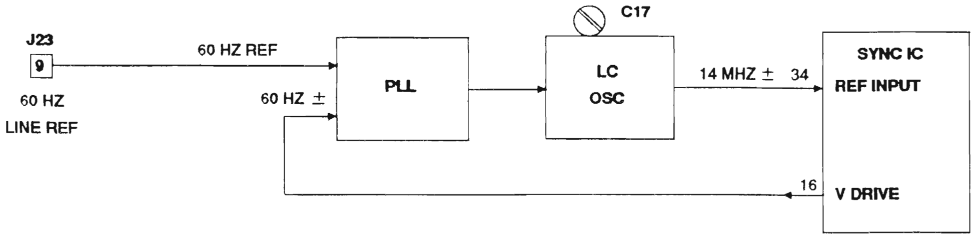


Figure 4-20. Functional Diagram, Reference Sync Sources

60-Hz rates. The sync IC provides its vertical drive (V drive) output to the PLL.

A Camera will revert to either line lock or crystal reference if an external sync reference is removed. A repositionable jumper on the board determines what the default mode will be.

Subsequent functional diagrams will supply greater detail for individual portions of these circuits.

Operating characteristics of several key ICs used with these circuits are summarized here:

4.19.1.1 Phase Locked Loop (PLL) — The phase locked loop (U11) compares signals on two inputs (reference and variable) and produces an error output if these signals are not on the same exact frequency and in phase. This output is integrated and applied to a Varactor (CR12), which controls frequency of the LC oscillator. The oscillator signal connects back to the variable input of the PLL.

4.19.1.2 Switch (U3) — Switch U143 is a triple two-channel analog multiplexer/demultiplexer. In the genlock functional diagrams, this switch is shown with a mechanical representation. Solid-state switching is actually used by this IC.

When a control input is high, the X-input connects through to the common pin. When a control inputs is low, the Y-input connects through.

All control input (9, 10, 11) for these switch stages are wired together by the circuit board. Thus all three poles switch to X or to Y in unison.

4.19.1.3 Sync Separator IC (U1) — The video sync separator extracts timing information, composite and vertical sync, and odd/even field information from a standard negative-going sync RS-170 video signal. This video signal must have an amplitude between 0.5 to 2.0 Vp-p at the input pin of the IC.

The vertical output is produced on the rising edge of the first serration in the vertical-sync period. A default vertical output is produced after a time delay if the rising edge mentioned above does not occur within the internally set delay period, such as might be the case for a nonstandard video signal.

Refer to figure 4-21 for waveforms from the end of one field to the beginning of the next field.

Four major sync signals are available from the IC:

1. Composite sync, including both horizontal and vertical timing information
2. Vertical-sync pulse
3. Burst gate / back porch clamp pulse (not used)
4. Odd/even (high/low) output to identify which field of an interlaced video is present at the input. This output is produced only when the input is composite video or composite sync.

4.19.1.4 One-shots — The one-shots used in the sync circuits are dual nonretriggerable monostable multivibrators. A one-shot cannot be retriggered on A or B until after timeout.

Each one-shot has an A input that sets on negative-going transitions and a B input that sets on positive-going transitions. Input A serves as an enabling input when held low, B when held high.

The clear input resets (Q low, not-Q high) the one-shot when taken low

Timeout is calculated by T=RCk, where T is in seconds, R is in ohms, C is in farads, and k is nominally 0.7 with a 0.01 μF capacitor and 0.8 with a 0.001 μF.

4.19.2 CRYSTAL OSCILLATOR

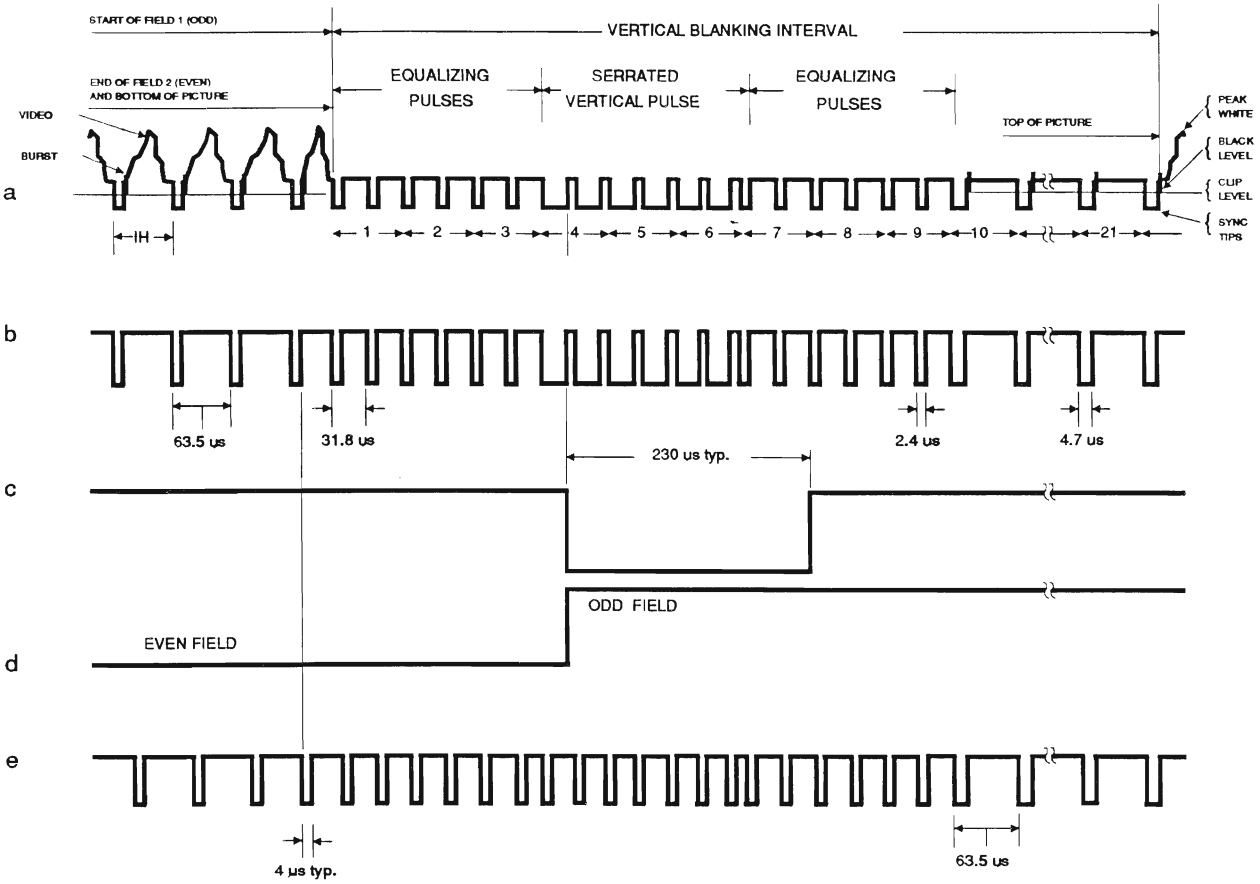
Refer to figure 4-22 for a functional diagram of the crystal oscillator stage. A sync/genlock board operates from crystal reference when the crystal / line-lock jumper is in crystal position and no external sync reference is being applied. Output from the crystal oscillator is OR'ed with the LC oscillator, which is not active during crystal operation.

With the jumper positioned at crystal and with no external sync input, resistor R6 pulls high, turning the crystal oscillator on. This also turns on Q1, pulling the line lock 60-Hz reference input to ground.

If sync is present, not-Q will discharge capacitor C6, pulling the control line low. The crystal oscillator will be turned off.

This removes the ground at the line-lock reference input too, but this input is switched off at the PLL input when there is sync input. The signal is thus blocked.

If the jumper is in the line-lock position, the control line for crystal operation is held low. Crystal is off, line lock reference input is no longer shunted to ground. It can pass through to the PLL. Note that this jumper determines the default operating mode of a Camera. A Camera operating from external sync reverts to either crystal reference or to line-lock reference if sync is removed.



a. Composite Video
b. Composite Sync
c. Vertical Output Pulse
d. Odd/Even Field Index
e. Burst Gate/Back Pouch Clamp (Not used)

Figure 4-21. Timing Diagram, Sync Separator IC

The line-lock stage is described in section 4.19.8.

4.19.3 PLL/LC Oscillator (Fig. 4-23)

This oscillator operates independently from the crystal oscillator. They are never on at the same time. When the crystal stage is turned off, the feedback resistor (R7) sets the NAND output high so that the LC oscillator can pass through U4-6.

When the LC oscillator is off, its feedback resistor (R24) conditions the NAND to pass the crystal oscillator signal through to the sync IC.

The LC oscillator is maintained on frequency by the phase locked loop (PLL). The PLL compares its variable input to a reference input and generates an error waveform if they are different. This is integrated by U5 and applied to the variable capacitance diode (CR12). Diode capacitance changes in response to this voltage. After the variable input is forced to the same frequency as reference, the circuit opposes any attempt by the oscillator to drift off frequency.

4.19.4 Genlock Control Line

Switching Control Lines. Several control lines are used to switch the genlock board among its various sync reference modes.

These lines are labeled CL1, CL2, and CL3 on the genlock functional diagram, figure 4-24.

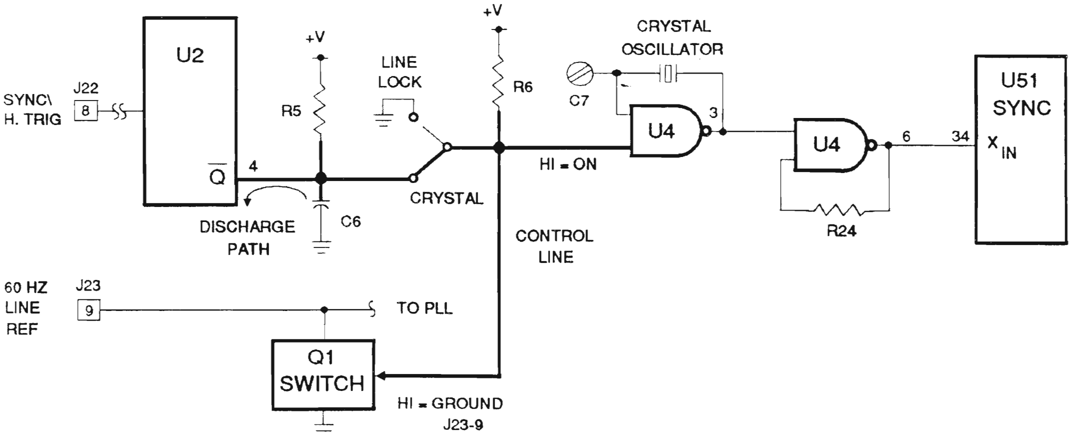


Figure 4-22. Functional Diagram, Crystal Oscillator

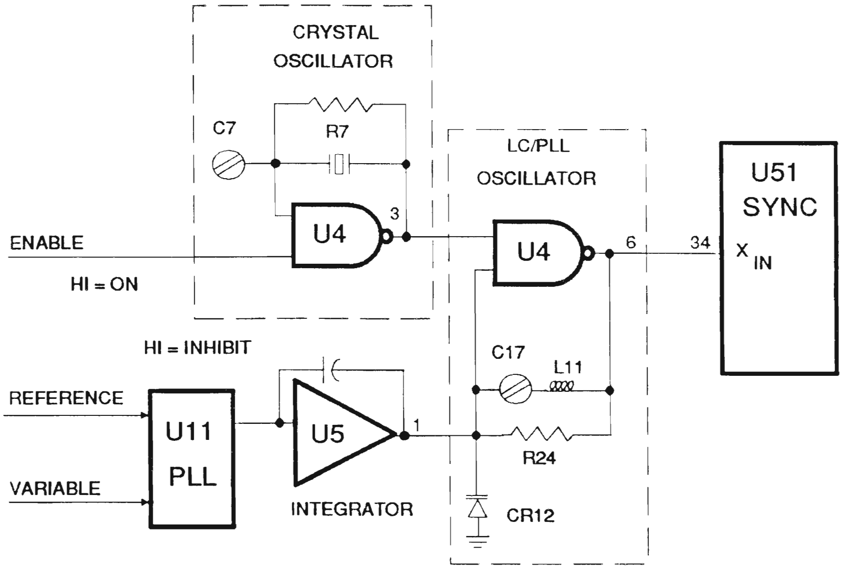


Figure 4-23. Functional Diagram, LC Oscillator

- CL1. Control Line 1 remains high unless U2-4 (not-Q) discharges the capacitor on the line. Not-Q discharges the capacitor when composite video, composite sync, or horizontal trigger is applied to J22-8. When CL1 is low, the two switch stages of U3 pass their X inputs (horizontal-rate signals) through to the PLL. This line also turns off the crystal oscillator if the jumper is positioned to select it for the default mode.

- CL2. Control Line 2 is held low by the line-lock jumper when the default sync reference is line lock. This allows the J23-9 input to pass the 60-Hz reference. It maintains the same state as CL1 when the crystal oscillator is jumpered in. Thus CL2 goes high with CL1 when the crystal oscillator is operating. This turns on FET Q1 and shunts to ground any 60-Hz signal on the line-lock reference input. This prevents it from passing through the switch Y-input to the PLL, even though the PLL is not active when crystal sync reference is being used. Grounding the line lock input prevents any possible problems.

- CL3. Control Line 3 goes high to turn off one-shot U10-1 when the vertical drive input (J2) is not required. This occurs when the CCU receives either composite video or composite sync on the sync/H. drive input (J3). With a composite input at the sync separator (U1), it generates an odd/even output. This output is coupled through one-shot U2-10 and Q to rectifier CR31. The rectifier produces positive voltage. Applied to the A input of one-shot U10-1 (an active low input), the CL3 voltage turns off the vertical drive input.

4.19.5 Composite Video Reference (Fig. 4-24)

Composite Video Reference. (This section is also true for composite sync as the input reference.) When composite video is applied to J22-8, the default sync reference (crystal or line lock) is turned off and other stages on. Not-Q at U2-4 discharges the capacitor, pulling control line CL1 low. This switches U3 so that its X-inputs pass through to the PLL for comparison.

The sync separator, U1, provides composite sync at one-shot input U2-1 and an odd-even waveform at one-shot input U2-10. (The line for horizontal-trigger down to U10-9 is not used when composite video or composite sync is the input reference.)

Composite sync contains equalizing pulses and field sync broad pulses (serrations) occurring at about a 32-kHz rate during the field blanking interval. These additional pulses are at twice the horizontal rate. Timeout duration of one-shot U2-13 extends past the equalizing pulse following each horizontal pulse. Since the one-shot is nonretriggerable, these pulses occurring between normal horizontal pulses are ignored.

Horizontal-rate pulses from U2-13 trigger one-shot U12-2. It supplies reference pulses through X and pin 14 of the switch to the reference input of the PLL (U11-3).

The variable input of the PLL (U11-14) receives feedback pulses from the sync IC H. Gate (U51-20). If H. Gate pulses are not in exact phase with the reference pulses, the PLL produces an error voltage to correct LC oscillator frequency. This brings the H. Gate pulses in-phase with reference.

The feedback H. Gate pulses from the sync IC pass through one-shot U12-12, which has an H. Phase potentiometer (R38) in its timeout circuit. Changing this adjustment varies sync position at the output of the Camera in relationship to the reference sync. This can be used to put the Camera in sync with equipment at a distant location from the Camera.

4.19.5.1 Odd-Even-Field Waveform —When the reference input at J22-8 is composite video or composite sync, an odd-even (O/E) field-identification waveform is generated by the sync stripper. (Refer back to figure 4-21.) This waveform occurs at a 30-Hz rate (once per frame). It triggers one-shot U2-10, which produces Q and not-Q output.

The not-Q (pin 12) output of U2 resets vertical in the sync IC (U51-40). Variable potentiometer R39 provides timeout control to shift the field in relation to horizontal (line) pulses.

The Q (pin 5) output turns off the vertical-trigger signal path by applying positive voltage to U10-1. To do this, the Q output is rectified by CR31, C36, and R41 to produce positive voltage (a logic high state) on control line 3 (CL3). This high-state connects to the A input of one-shot U10-1 and disables it. The vertical-trigger signal path is blocked. (Remember that this takes place only when composite video or composite sync is the input at J22-8. When horizontal-trigger pulses are supplied there, the sync separator does not produce an odd-even output waveform. Thus the one-shot does not produce an output to be rectified for turning off the vertical-trigger signal path.)

4.19.6 Composite Sync Reference

Operation of the genlock board with composite sync as the input is identical to the operation described for composite video input. Refer to section 4.19.5.

4.19.7 H and V Trigger Reference

For the horizontal trigger and vertical trigger reference, refer to figure 4-24. In this mode, the sync/genlock board uses input pulses from two separate input lines as a sync reference.

Horizontal-trigger pulses enter J22-8 and pass to the sync separator. It does not generate an odd-even field output (U1-7) because there are no equalizing pulses. This output remains inactive when the sync separator input is horizontal triggering.

Horizontal-trigger pulses from pin 1 of the sync separator triggers one-shot U2-1. The not-Q output discharges the capacitor (C6), and control line CL1

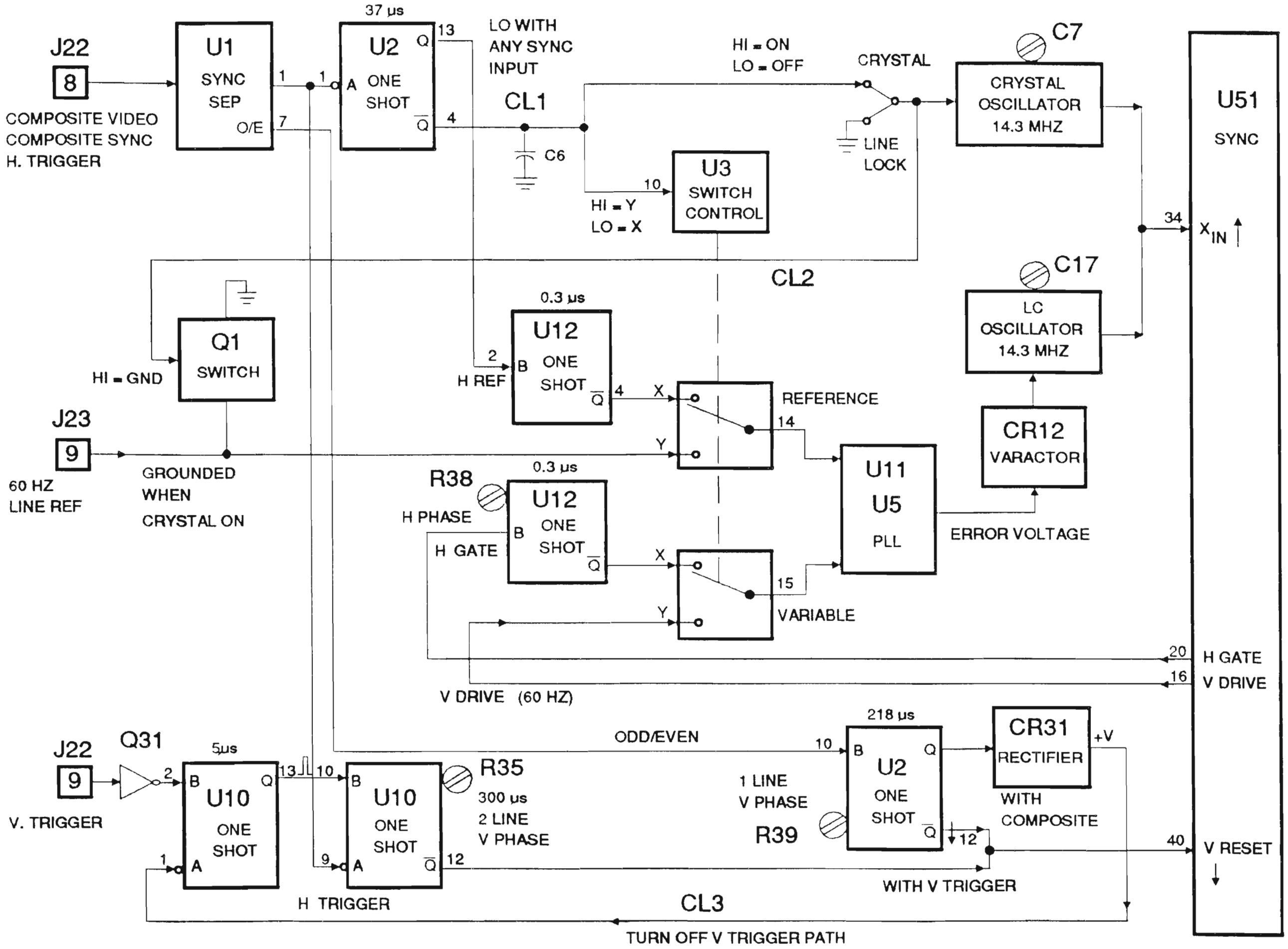


Figure 4-24. Functional Diagram, Genlock

pulls low. When this line is low, the X inputs of switch U3 connect to the PLL inputs.

The line being low also turns off the crystal oscillator if it was the default sync reference. If line lock was the default reference, the input at J23-9 no longer connects to the PLL because X inputs become active with H. triggering at J22-8. The Y inputs are turned off.

The sync IC (U51) must not be reset more than once per frame. (A frame consists of two fields, the odd field and the even field.) It must not be reset twice per frame, as would happen with a reset pulse occurring at the start of each field. This requirement is met by generating the reset only when the horizontal-trigger pulse and beginning of field blanking occur simultaneously—not when they are offset by a half line.

To do this, vertical trigger is applied to one-shot U10-2, which has a short (5 µs) timeout period. This narrow pulse places an enable on one-shot U10-10 for 5 µs. If the horizontal-trigger pulse is applied to the A input (U10-9) during this time, a vertical-reset pulse is generated at not-Q (pin 12).

If the horizontal-trigger pulse does not occur at U10-9 during the timeout (enable) period, the one-shot does not get triggered to generate a vertical reset pulse. It would then occur at the start of the next field.

(This vertical reset pulse is not required every frame. If for some reason the vertical-trigger input were removed, the genlock board would continue to maintain both horizontal and vertical sync, using only the horizontal-trigger pulses as a reference. This is not a typical operating mode.)

4.19.7.1 Horizontal-Trigger-Only Sync Reference— Using only horizontal-triggering pulses as a sync reference is not a typical application of the genlock circuits. But it will lock to these pulses without need for a vertical reset pulse. In this case, the vertical interval would not be referenced to any external vertical reference.

However, if vertical triggering pulses were applied to J22-9 and then removed, the horizontal-triggering pulses applied to J22-8 would maintain the genlock board in both horizontal and vertical sync. (Again, this is possible but it is not a typical operating mode. Any "glitch" could cause vertical to go out of sync.)

4.19.8 Line Lock Reference

Line Lock Reference. For the genlock board to operate from a 60-Hz line reference (derived from ac input power to the Camera), the jumper must be in line lock, not crystal, position. Then when no sync is being supplied to J22-8, 60 Hz from P23-9 passes through input Y of the switch to pin 14 and on to the reference input of the PLL.

The variable input of the PLL receives vertical drive (60 Hz) as feedback from the sync IC (U51-16). This passes through input Y to pin 15 of the switch. If vertical drive is not in-phase with the reference input, the PLL stage produces an error voltage, which is applied to the Varactor at the LC oscillator. The varactor changes capacitance to tune the LC oscillator to the frequency required for producing vertical drive in exact phase with the reference input. (The LC oscillator frequency (14.318 MHz) is divided down in the sync IC to the vertical drive frequency of 60 Hz.)

4.20 SYNC DRIVER

4.20.1 Sync Waveform Generator (U51)

Various timing waveforms are produced by the sync generator IC (U51). Inputs and outputs related to reference signals are described in this section.

Most of the timing waveforms produces are used by the sensor board and the driver board in the Camera Head. Refer to section 4.1 for these signals.

4.20.2 Sync IC (U51) Reference Inputs and Outputs

The sync IC (U51) has two inputs and two outputs that are used to maintain timing with the sync reference circuits.

- Pin 34, labeled XIN, accepts horizontal-rate timing pulses from the active oscillator (crystal or LC/PLL). It triggers with positive-going transitions.

- Pin 40, labeled VRS (Vertical ReSet), can accept a pulse once each frame (30-Hz rate) to maintain vertical timing. This input triggers on negative-going transitions. In theory, the sync IC does not require this vertical-reset pulse every frame. It could be applied to establish the vertical interval in proper time and then removed. As a practical matter, though, continuous vertical reset is provided to ensure that vertical sync is maintained during times when an external sync reference is provided to the Camera. Otherwise, any "glitch" in the circuit could cause the vertical to go out of sync.

- Pin 20, H GATE, of the sync IC provides horizontal-rate pulses. They are used as feedback to the

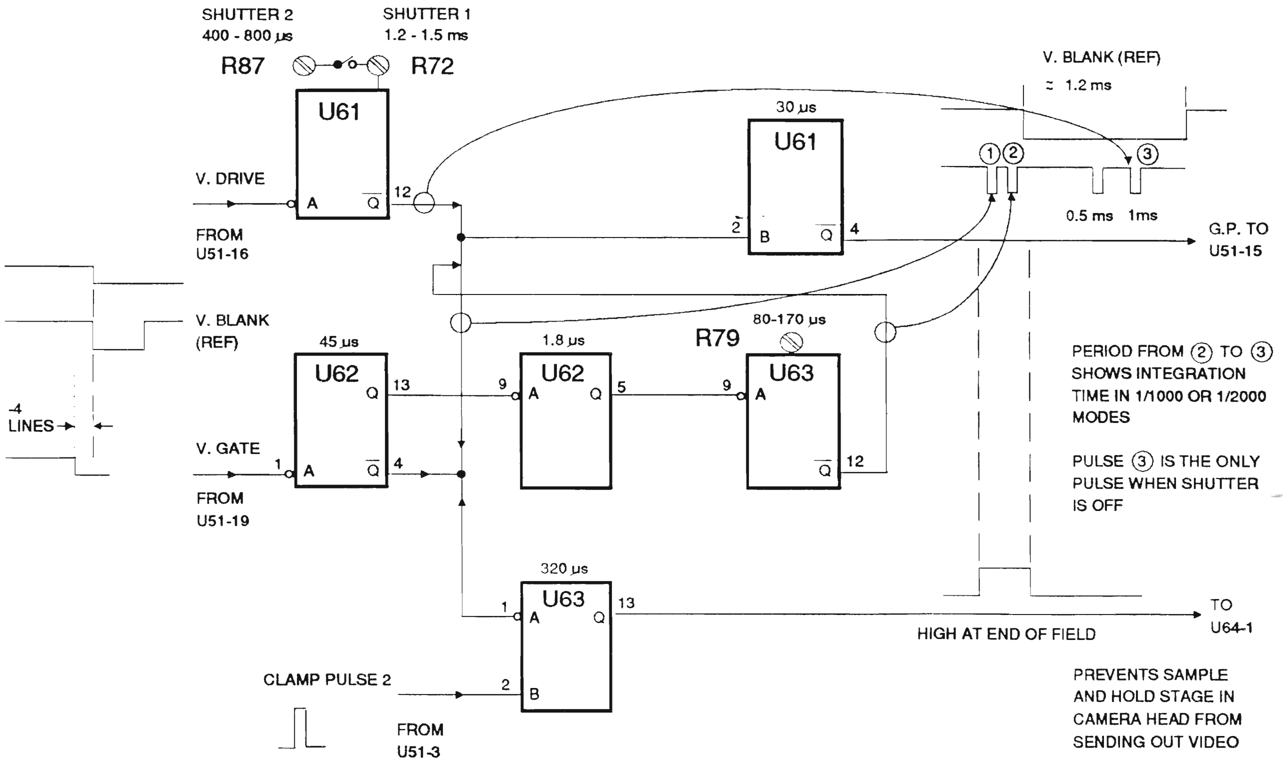


Figure 4-25. Functional Diagram, Shutter Stage

PLL when the sync reference is composite video, composite sync, or horizontal triggering.

- Pin 16, VD (Vertical Drive), of the sync IC provides vertical-rate (60- Hz) pulses. They are used as feedback to the PLL when the sync reference is line-lock mode.

4.21 SHUTTER (FIG. 4-25)

Light for a field is normally allowed to integrate on the sensor for 1/60 second (16.67 ms) before it is transferred into the storage area. The shutter stage, though, limits the field integration period to only 1/1000 second (1 ms) or 1/2000 second (0.5 ms) before transfer into storage. A shorter integration period provides an electronic shutter effect. This produces stop action for use when relative motion exists between the Camera and scene being viewed. Effective sensitivity, though, is decreased by about four f/stops at 1/1000 and five f/stops at 1/2000.

Figure 4-25 is a functional diagram of the shutter circuits. Figure 4-26 shows waveforms related to the shutter circuit. All IC stages shown are non-retriggerable one shots. Timeout is shown for each one-shot. The shutter stage has two outputs. The functional descriptions will first be keyed to the two outputs and then to the input references and circuit details.

4.21.1 G.P Pulse Output

At the top right in the figure is a three-pulse waveform provided to the G.P. input of the sync IC (U51-15). (With the shutter off, only pulse 3 is present.) The G.P input initiates within the sync IC a pulse to the sensor that moves the image integrated on its surface into storage. The two pulses in succession (1 and 2) clear the sensor surface twice. The second clearing eliminates any possible image left on the sensor. Some image may have remained because the lens on a Camera operating in a shutter mode is typically opened four or five f/stops beyond the normal f/stop.

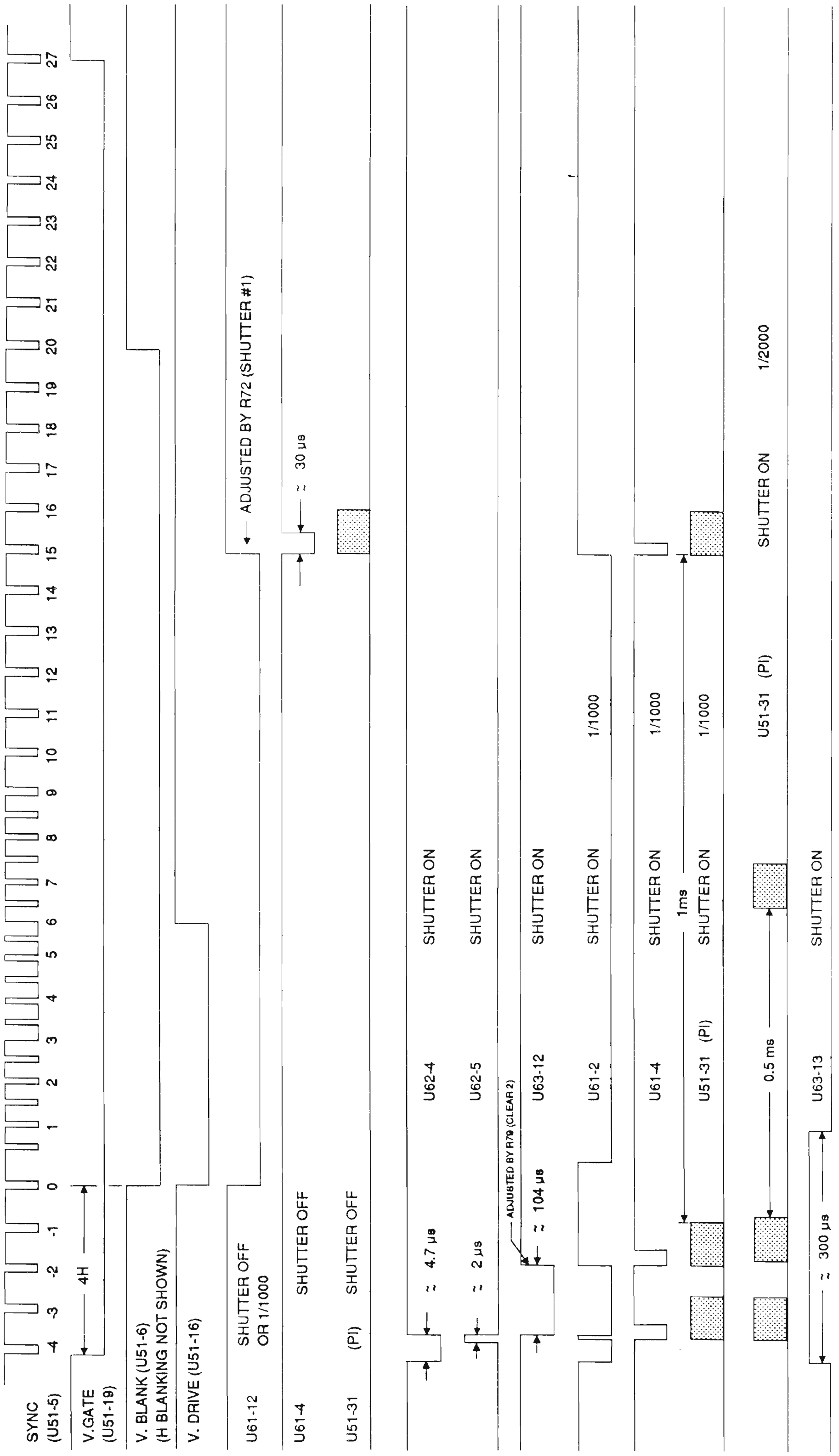


Figure 4-26. Timing Diagram, Shutter Stage

In shutter mode, the sensor is allowed to integrate for 0.5 ms or 1 ms before the frame image is transferred into storage for readout. But the sensor continues to integrate image on its surface for the remainder of the field period, about another 15 ms. Allowing four or five f/stops of additional light to integrate on the sensor for nearly the full field period results in a large buildup of image. Clearing the sensor surface twice in rapid succession, as previously mentioned, ensures that no residual image remains at the start of integration for the next field.

In summary then, the time between pulse 2 and pulse 3 is the integrating period used to produce video when in shutter mode. This is either 1 ms (1/1000 s) or 0.5 ms (1/2000 s). When pulse 3 is sent to the sync IC, the sensor moves the integrated field image down into storage. (The images moved down by pulses 1 and 2 are not used.) Other signals are then initiated from the sync IC that cause this image to be read out of the sensor storage area. This ultimately passes to the video board in the CCU.

4.21.2 Sensor Output Stop Pulse

Pulse 1 and pulse 2 (discussed in 4.21.1) occur during active video time just before vertical blanking. (Image is moved off the sensor integrating surface twice.) To prevent crosstalk interference from appearing on lines just before vertical blanking (bottom of field), pulses to the sensor that transfer the image are halted during this double clearing.

The pulse to U63-1 (a multiplexer) prevents these output clocking pulses from passing to the sensor.

4.21.3 Reference Waveforms

The previous two sections described outputs generated from the shutter stage and their purpose. This section describes the reference waveforms used to produce those outputs.

The shutter stage uses two reference waveforms to generate the three-pulse G.P output, which occurs at field rate:

Vertical Drive. V. Drive has a leading edge coincident with vertical blanking. It is used because it does not contain any of the sync pulses contained in vertical blanking.

Vertical Gate. The V. Gate can be considered as a slightly wide vertical-blanking pulse. It starts four lines before V. blanking (and ends after it).

Clamp Pulse 2. CP2 occurs at the horizontal rate. It is positioned in time on the back porch of each H. blanking pulse.

4.21.4 G.P Output Generation

Pulse 1 Generation. Pulse 1 at the V.G. output is produced when V. gate triggers one-shot U62-1, and its not-Q output times out. This triggers one-shot U61-2, and it produces pulse 1.

Pulse 2 generation. Pulse 2 is produced when the Q output of U62-1 triggers U62-9. Its Q output (pin 5), in turn, triggers U63-9. Timeout of this one-shot is adjusted so that pulse 1 and 2 are close to each other, but separate. When U63-12 times out, it triggers U61-2 to produce pulse 2.

Pulse 3 Generation. Pulse 3 is initiated by the timeout of U61-12. It is the position in time of pulse 3 that determines the shutter integration period. This is adjusted by R72 for 1/1000 and R87 for 1/2000. Note that R87 bridges R72 when 1/2000 is selected. Thus, shutter timing for 1/2000 is also dependent on the setting of the 1/1000 potentiometer.

4.21.5 Multiplexer Control Output

One-shot U63-13 produces a high-state output to turn off multiplexer U64-1. The multiplexer must be off during the last few lines on each field. When off, it prevents pulses from reaching the sensor that would pass video to the CCU.

To obtain this timing, a V. rate pulse and an H. rate pulse are used. Four lines before V. blanking, the V. gate pulse triggers one-shot U62-1. Its not-Q (pin 4) output provides a low state to the A input of U63-1. This acts as an enable. Pulse CP2, which occurs at the horizontal rate, then triggers the one-shot on input B (pin 2). Its Q output (pin 13) goes high. This output turns off the multiplexer.

4.22 INTEGRATE

Refer to figure 4-27 for the functional diagram and waveforms related to the integration circuit. The schematic diagram for this circuit appears on figure 7-4, sheet 4 of 4.

The PI waveform shown on the timing diagram is associated with the sensor IC at the Camera Head. These PI pulses transfer the charge built up on the surface of the sensor down into storage. This occurs at the end of each field. during vertical blanking.

To allow the sensor to integrate beyond a single field period, these pulses must be turned off. This integration circuit provides that capability.

To initiate integration through multiple field periods, a negative pulse of the desired duration is applied to J22-13. This causes three things to happen:

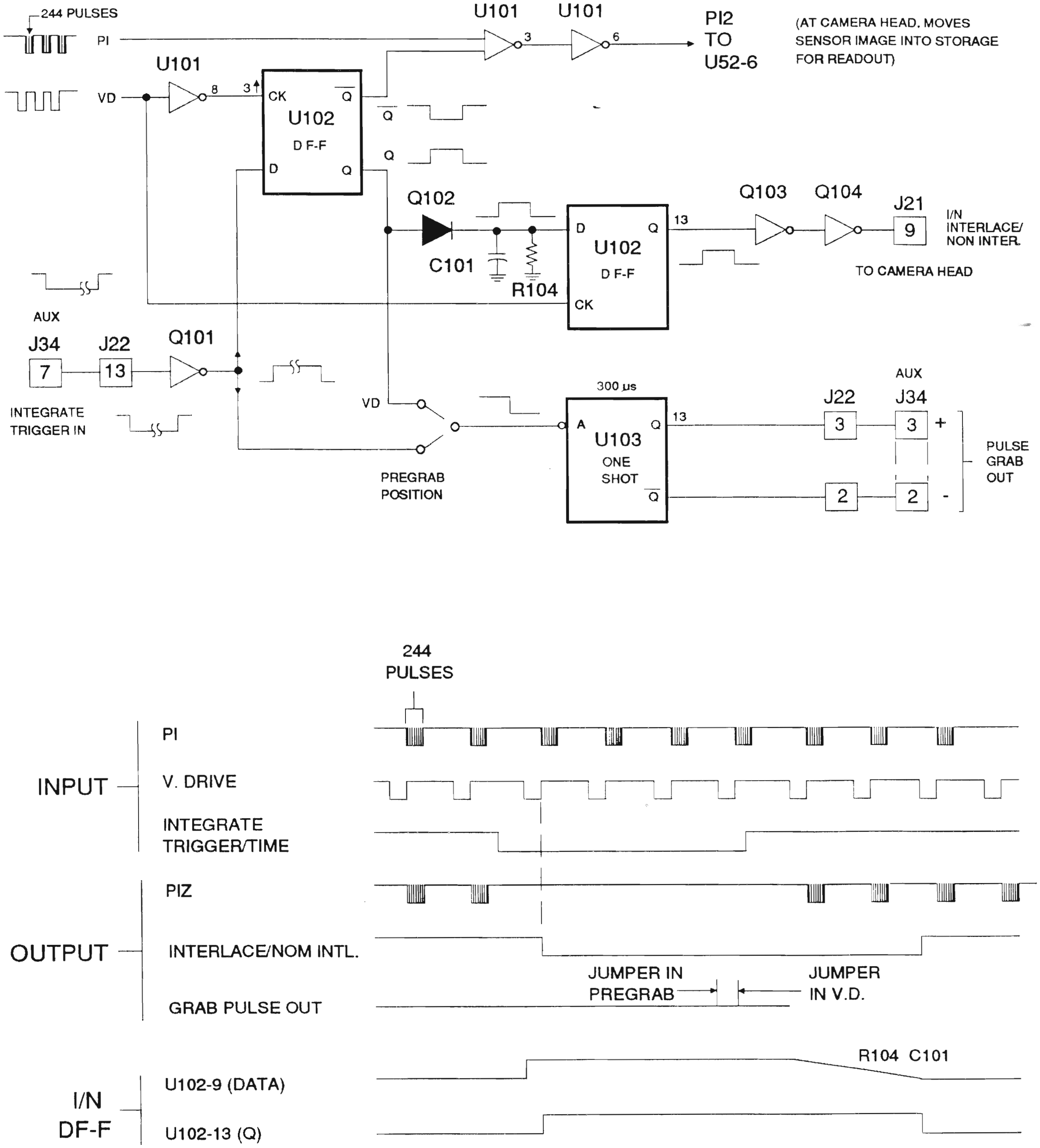


Figure 4-27. Functional Diagram, Integration Stage

1. The PI (PI-2) pulses to the sensor are turned off
2. The sensor is changed from interlaced to non-interlaced mode
3. A grab-pulse output is generated and routed to the CCU rear panel at the end of the integration period.

The following paragraphs will describe each stage in regards to the functional block diagram and timing waveform.

4.22.1 Integrate Trigger Pulse

This pulse initiates integration (timed to the vertical interval).

It is applied to the CCU rear panel auxiliary connector (J34-7). Duration determines the number of field periods through which the sensor is allowed to integrate. Two fields is the minimum period. About four seconds is the maximum period. (The maximum period is limited by deterioration of picture quality.) Note that the leading and trailing edges of this pulse determine when integration begins and ends only in relation to the vertical drive pulse.

4.22.2 PI-2 Output

Inverted by Q101, the pulse is applied as a high state to the data input of U102, a D flip-flop. When vertical drive arrives, the flip-flop sets. Thus, Q goes high and not-Q low.

Not-Q then prevents PI pulses from passing through U101-3. The sensor will continue integrating.

4.22.3 I/N Output.

Interlace/non-interlace. The Q output is applied to the data input of flip-flop U102-13. Vertical drive also sets this flip-flop, but note that it is the trailing (rising) edge of vertical drive that clocks the flip-flop. This occurs nine lines into vertical blanking. (That is, the drive pulse is nine lines wide.) Pin 13 (Q) goes high. This changes the sensor IC from interlaced to non-interlaced mode. The sensor then has better "dark current" characteristic, and noise is reduced.

At the end of the integration period, Q102 is switched off. Capacitor C101 then must discharge through R104. This RC time is about 10 ms. The sensor is held in the non-interlace mode for an additional field after the end of integration.

4.22.4 Grab Pulse Output

The grab pulse occurs at the end of the integration period. This pulse is about 300 μs wide. It is available on the rear panel of the CCU, at auxiliary connector J32, pins 2 and 3. Note that this is a complementary output.

With the jumper in the vertical drive (VD) position, the leading edge of this pulse is coincident with the leading edge of the first vertical drive (and vertical blanking) pulse immediately following removal of the integrate trigger pulse.

With the jumper in pre-grab position, the grab-pulse leading edge will be coincident with the trailing edge of the integrate trigger pulse.

SECTION V
MAINTENANCE

Only technicians familiar with video circuits and television camera maintenance should attempt procedures in this section of the manual.

Adjustment procedures are given for all adjustments. Performance verification tests follow the setup adjustments. Contact the Customer Service Department if assistance is needed in maintaining the Camera.

5.1 TEST EQUIPMENT REQUIRED

Table 5-1 lists the equipment needed to make the setup adjustments and to perform evaluation test procedures on the Camera. The required characteristics given are not necessarily the full limits of the equipment recommended. Instead, they reflect only the capabilities necessary to measure electrical and optical characteristics of the Camera to the required accuracy.

NOTE

The resolution chart at the rear of this manual can be substituted for the test jig listed in table 5-1; however, the results obtained may not be accurate due to paper shrinkage and printing limitations.

5.2 CLEANING AND LUBRICATION

CAUTION

This Camera contains sensitive devices that can be damaged by static discharge. Use appropriate static control methods when working inside the Camera or at connector pins when cables plugs are removed.

Remove the Camera Head cover and the CCU cover from the chassis to reach circuit areas inside. These procedures are in section 5.6 1 and 5.6.5. Observe all CAUTIONS when handling Camera.

Periodically clean the interior circuit areas of the Camera Head, including exposed glass surfaces on the lens and the window in front of the sensor faceplate, to remove accumulated dust and film.

5.2.1 Circuit Board Cleaning

Clean circuit areas with a soft bristled brush and dry low-pressure air. Remove film buildup from contact pins with a soft tissue moistened with alcohol.

5.2.2 Lens and Window Cleaning

The window (or IR filter) in front of the glass faceplate of the image sensor can be cleaned by wiping gently with a cotton swab soaked in a lens cleaner or in methyl alcohol. Never rub with a dry swab.

The area between the window and the sensor faceplate is a sealed area that should not require cleaning unless the Camera Head is disassembled.

NOTE

The sensor faceplate is in the focal plane of the Camera. Any contaminants on this surface will show up in the picture. Dry pressurized air can be helpful in removing these contaminants.

5.2.3 Lubrication

The Camera does not require any lubrication.

5.3 TROUBLESHOOTING AND INSPECTION

Become familiar with all circuits in the Camera before attempting any troubleshooting. Observe all CAUTIONS when handling or troubleshooting the Camera. If a problem occurs, and the cause is not immediately apparent, first try to isolate it to the circuit group where it is originating. Check for correct dc supply voltages, and then check for the proper waveforms at the inputs and outputs of the circuit

Table 5-1. Recommended Test Equipment

TEST EQUIPMENT	REQUIRED CHARACTERISTICS	RECOMMENDED EQUIPMENT
Picture Monitor	RS-170 input	Cohu 9615B
Digital Voltmeter	0-30 Vdc, 0-130 Vac ±1% accuracy	Hewlett-Packard Model 3435A
Oscilloscope, General	50 MHz Bandwidth, Dual Channel	Tektronix Model 455
Waveform Monitor	RS-170	Tektronix Model 1730
RS-170 Sync Generator	Composite sync, video, and H&V drive outputs	Tektronix Model TSG-170A
Frequency Counter	20 MHz, 1 Hz resolution	Hewlett-Packard Model 5314A
Power Auto Transformer	100 to 130 Vac output	Any model
Test lens	16-mm, f/1.4, C-mount, focus within 2 feet, manual iris type	Any high quality lenses
Camera Test Jig	Must support Camera in a fixed position and provide a backlighted TV resolution chart capable of resolving at least 560 lines. If used for adjusting C-mount backfocus, must have a collimator lens.	Cohu CTJ-2
Neutral Density (ND) Filters	Must be capable of filtering out enough light to prevent picture blooming during test and adjustment procedures	Kodak Wratten series (for incandescent illumination use metallized ND filters)
Light Meter	Must be capable of measuring illumination in lux or footcandles	Photo Research System 500
Spline Wrench	No. 2 (0.048 in.) 4 fluted type	Various standard sources

boards. Appropriate dc supply voltages are listed in table 5-6. Further troubleshooting procedures appear in table 5-2.

Always check for the correct input power as the first step in troubleshooting an inoperative Camera.

5.4 ADJUSTMENTS

CAUTION

Always remove power to the Camera Control Unit before sliding off the cover. Turn off power before sliding off the Camera Head cover.

CAUTION

This Camera contains sensitive devices that can be damaged by static discharge. Use appropriate static control methods when working inside the Camera or at connector pins when plugs are removed.

NOTE

Making adjustments other than those listed in table 2-2 of the installation section may void the warranty of a new Camera. Refer to the back cover for warranty information.

A program of periodic maintenance will insure optimal performance of the Camera. Testing and adjustment may also be necessary after a board replacement, a long storage period, or shipment.

Refer to figure 5-1 and the procedure below and to set up equipment for these tests and adjustments.

To set up the Camera and test equipment, proceed as follows:

1. Turn off Camera power.

2. Clean the window in front of the sensor faceplate according to the procedure in section 5.2.2.

3. Install a 12- to 16-mm focal length test lens. It must have a manual iris.

4. Temporarily connect the signal from the video output terminal (J1) on the rear panel of the Camera to a high resolution monochrome television monitor.

5. Turn on the monitor, apply power to the Camera, and determine whether a picture can be obtained.

6. If the Camera provides a picture, continue to step 7 to perform the systems tests and adjustments. Otherwise, use the troubleshooting chart (table 5-2) to determine the problem. If the problem cannot be determined, contact the Customer Service Department for help.

7. Unplug the CCU power cord.

8. Disconnect the CCU from the monitor.

9. Remove the Camera Head and CCU covers, as described in sections 5.6.1 and 5.6.5.

10. Place the Camera Head on the test jig, facing the tv resolution chart (fig. 5-2 and table 5-1). If a test jig is not available, tape the resolution chart from the back of this manual to a wall or other surface parallel to the face of the Camera. Then evenly illuminate the chart with about 1076 lux (100 footcandles) of 2854 K light.

11. Position the Camera so the optical axis of the lens is perpendicular to and centered on the chart. Focus the lens using the lens focusing ring for the distance separating the Camera from the test pattern.

12. Connect the test equipment as shown in figure 5-1. If a waveform monitor is not available, use the oscilloscope to view video waveforms. Use 75-ohm coax (RG-59/U) for all connections. Terminate the last item of equipment with 75-ohms.

13. Proceed to section 5.4.1 for initial settings to be made.

5.4.1 Initial Settings

Prior to starting the adjustment procedure, front panel switches and control knobs, circuit board jumpers, and a circuit board potentiometer must be properly set.

Set front panel controls as follows:

•**Shutter**	off
•**Video** Polarity	(down)
•**Auto Black**	**Off** (down)
•**OFFSET**	**Manual**
•**GAMMA**	**0.5 - 1.0**
•**GAMMA**	Full cw (1.0)

Table 5-2. Troubleshooting.

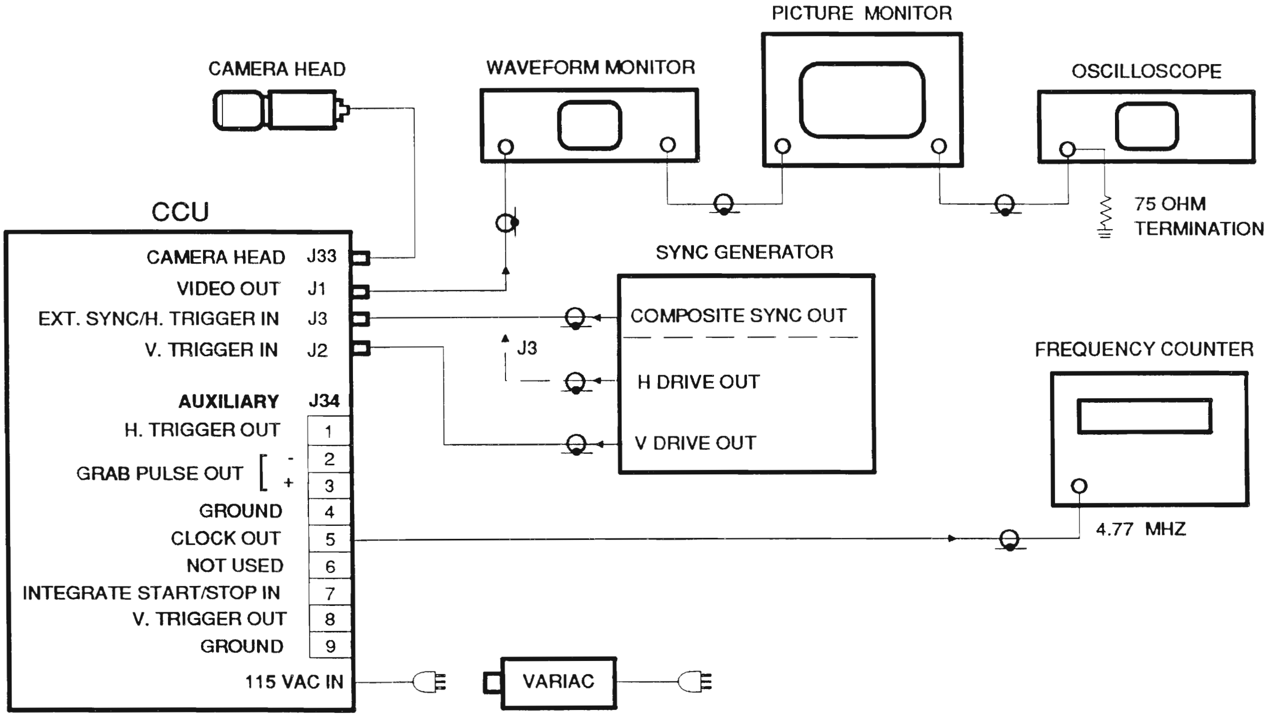
SYMPTOM	PROBABLE CAUSE	LOCATION	ISOLATION PROCEDURE
No image on tv monitor and power is being supplied to CCU	Blown fuse	CCU rear panel	Check fuse in fuse holder
			Check Camera-to-monitor cable or cables (J33)
	Defective bridge rectifier (CR201)	Video/auto/P.S. board	Check for B+ at C203
	Defective voltage regulator	Video/auto/P.S. board	Check power supply voltages (table 5-3)
	Defective agc IC (U5)	Video auto/P.S. board	Check for video signals at U5-7
	Defective gamma stage	Video/auto/P.S. board	Check for video at J9-7
			Jumper missing at J9-6 and -7
	Defective aperture stage	Video/auto/P.S. board	Check for video at J19-5
	Defective processor stage	Video/auto/P.S. board	Check for video at U15-6
No video or stairstep output	Defective processor circuit	Video/auto/P.S. board	Check U16 & Q142
	Defective clamp pulse	Video/auto/P.S. board	Trace clamp pulse from J13-6
	Defective blanking pulse	Video/auto/P.S. board	Trace blanking pulse from J13-5
	Defective sync IC (U51)	Sync/genlock board	Check waveforms at J23 & J33
	Defective sensor IC (U1)	Camera Head	Check for 3 channels of video at pins 11, 13, & 25 of J33 (CCU)
Picture at monitor will not lock	No sync in video	Video/auto/P.S. board	Check sync adder (Q142)
	Defective Y1 crystal	Video/auto/P.S. board	Check for 14.318180 MHz clock at TP51

Table 5-2. Troubleshooting (Continued)

SYMPTOM	PROBABLE CAUSE	LOCATION	ISOLATION PROCEDURE
Noise in video	Inadequate scene lighting	None	Increase scene lighting
	SHUTTER switch to LO or HI without sufficient scene lighting	CCU rear panel	Set switch to OFF
	GAIN switch set to Manual (fixed gain) with control fully ccw (no additional gain)	CCU front panel	Rotate GAIN control cw or set switch to Auto
Noise in video (continued)	Low output from Camera Head	Video/auto/P.S. board	Verify 450 mVp-p video on pins 11, 13, and 25 of J33
	Improper video setup	Video/auto/P.S. board	Perform video setup adjustments (section 5.4)
	Defective video output transistor	Video/auto/P.S. board	Check video signal at Q142
Poor contrast	Improper setting of black level	Video/auto/P.S. board	Check setting of setup (R152)
	Improper setting of GAMMA control	CCU front panel	Adjust control
Ghosts in picture	Improper termination of video	At monitor	Check that video cable is terminated into 75 ohms at monitor
Horizontal interference bars	Ripple in one or more of the supply voltages	Power supply board	Check voltage supplies for excessive ripple
Vertical interference bars	Black & white balance potentiometers	Video/auto/P.S. board	See section 5.4.21
Bending or flag waving at top of monitor when genlocking	1L or 2L vertical phase potentiometers (R39 and R35)	Sync/genlock board	See sections 5.4.17
Smearing	Shutter 2 (R87) 1/2000 s	Video/auto/P.S. board	See section 5.4.15

Table 5-2. Troubleshooting (Continued)

SYMPTOM	PROBABLE CAUSE	LOCATION	ISOLATION PROCEDURE
Interlacing not clean	Sensor IC voltages out of adjustment	Sensor board	Perform power supply setup procedures (section 5.4.2)
	Shutter 1 (R72)	Video/auto/P.S. board	See section 5.5.5
	Defective sync generator IC	Sync/genlock board	Check sync output signals
	Defective automatics	Video/auto/P.S. board	Perform setup procedures (sec 5.4)



NOTES 1. SEE SECTION 2 FOR ADDITIONAL CONNECTION DETAILS
2. ALL COAX IS 75 OHM

Figure 5-1. Test Equipment Setup, Camera Adjustments

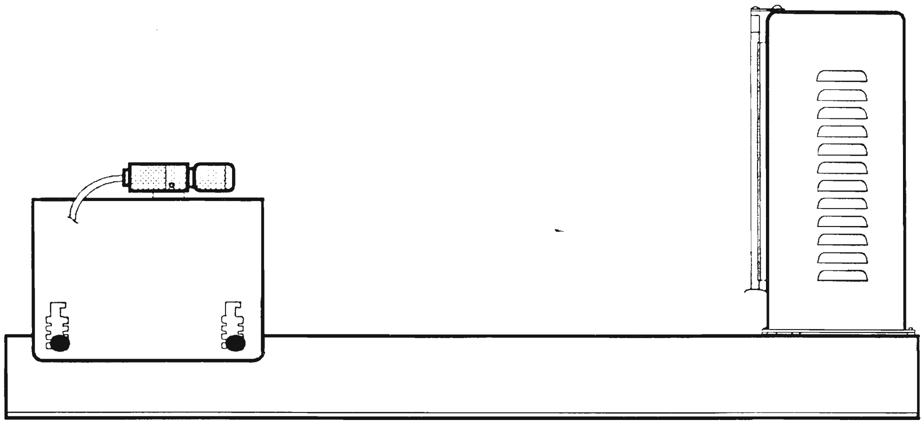


Figure 5-2. Equipment Setup, Camera Test Jig

Set circuit board jumpers as follows:

> **NOTE**
>
> *For brevity, the video/auto/power-supply board contained in the CCU will be referred to as the video board throughout the maintenance procedures. The sync/genlock board will be referred to as the sync board. Where required for clarity, the full designations will be used.*

Refer to tables 5-3 and 5-4 for a listings of adjustments and jumpers on the two circuit boards in the CCU. Table 5-5 lists the single adjustment in the camera head, integration potentiometer R15.

•Variable phase	180° & B
•XTAL-LL	XTAL
•PREGRAB - V.D.	V.D.
•J9 jumper	J9-6 to J9-7

Set the following potentiometer as indicated:

•White Clip (R147)	full ccw
•PK-AVG (R107)	full cw

Remove all inputs from the following rear panel connectors on the CCU:

- Integration (J34-7)
- Sync/H. Trigger (J3)
- V. Trigger (J2)

Proceed to section 5.4.2 to make power supply adjustments and verifications of voltages.

5.4.2 Power Supply Adjustments

Refer to figure 5-3 for the location of power supply adjustments on the video/auto/power-supply board. Potentiometer R207 (-VSS) and R209 (+VAB) will be final adjusted in section 5.4.14. The line lock reference circuit is also adjusted in this procedure. Proceed as follows:

1. Connect the power cord and turn the CCU on.
2. Refer to table 5-6 and make the adjustments and voltage verifications listed.
3. Connect the oscilloscope to J13-9, the line lock reference output (60 Hz).
4. Adjust R228 (phase trim) so the waveform is a square wave.
5. Proceed to the crystal oscillator adjustment, section 5.4.3.

5.4.3 Crystal Oscillator Adjustment

Crystal oscillator frequency must be set before proceeding with other adjustments. Figure 5-4 shows adjustment locations on the sync/genlock board. Proceed as follows:

1. Connect the frequency counter to TP51.
2. Adjust C7, on the sync board, to obtain 14,318,181±40 Hz.
3. Proceed to the stairstep generator adjustment.

Table 5-3. Adjustments and Test Points, Video/Auto/P.S. Board (A2)

REFERENCE DESIGNATION	FUNCTIONAL NAME	CIRCUIT FUNCTION
R1	White balance 1	Adjusts white level in channel 1 to the reference channel
R2	White balance 2	Adjusts white level in channel 2 to the reference channel
R43	Black balance 1	Adjusts black level in channel 1 to the reference channel
R48	Black balance 2	Adjusts black level in channel 2 to the reference channel
R61	*Offset	Shifts video envelope up 5 units or down 85 units relative to blanking (**OFFSET** switch must be in **Manual**)
R68	*Gain	Provides 20 dB additional gain, but with some additional noise (**GAIN** switch must be in **Manual**)
R76	Gain minimum	Sets gain of the front panel **GAIN** control to 0 dB when it is fully ccw
R77	Gain maximum	Sets gain of the front panel **GAIN** control to 20 dB when it is fully cw
R93	1.5 gamma set	Sets the gamma signal path to 1.5
R103	Peak-average	Determines whether the agc circuit respone more to video white peaks or to the average video level. Setting depends on the camera application and experience
R106	Agc level	Sets the agc circuit to provide 90 units video when it is active
R111	*Gamma	Combines normal video with gamma correction video to provide 0.5 to 1.0 and 1.0 to 1.5 video output, depending on the position of the related switch
R115	*Sharpness	Is set to provide 6 dB overshoot on black to white and white to black transitions in video. Give appearance of better picture

*DESIGNATES A FRONT PANEL CONTROL

Table 5-3. Adjustments and Test Points, Video/Auto/P.S. Board (A2) (Continued)

REFERENCE DESIGNATION	FUNCTIONAL NAME	CIRCUIT FUNCTION
R131	Reverse setup	Shifts the video envelop to maintain proper reference to blanking and black level when in the video negative mode
R147	White clip	Determines maximum level of white peaks. Typically set to clip at 120 units
R152	Setup	Determines reference black level. Typically set for 7.5 units above blanking (See fig. 2-6)
R173	Right edge	Sets right edge of the window so that black level monitoring is stopped 2 µs before blanking at the end of a line
R184	Auto black level	Sets reference black level when in the Auto Black mode (Typically 7.5 units)
R203	+VDD set	Sets +VDD for +11.6 V dc
R207	-VSS set	Sets -VSS for -9.5 V dc
R209	+VAB set	Sets +VAB for + 5 V dc
R228	Phase trim	Shifts line lock sync reference slightly to allow exact settings
R309	Step No.	Sets width of last (black) step. Is made same width as other steps
R324	Step level	Sets stairstep for 100 units video
R346	Black Balance 3	Compensates for any difference between dark current from the sensor during clamp interval (the reference) and dark current during active video. This difference would appear when amplified by a gain increased in either **Manual** or **Auto** modes.
	JUMPERS	
—	0 - 180	Establishes either 0° or 180° as the basic phase for line lock sync reference (A-B-C jumper can then further shift it)
—	A-B-C	Sets 60° increments for line lock sync reference

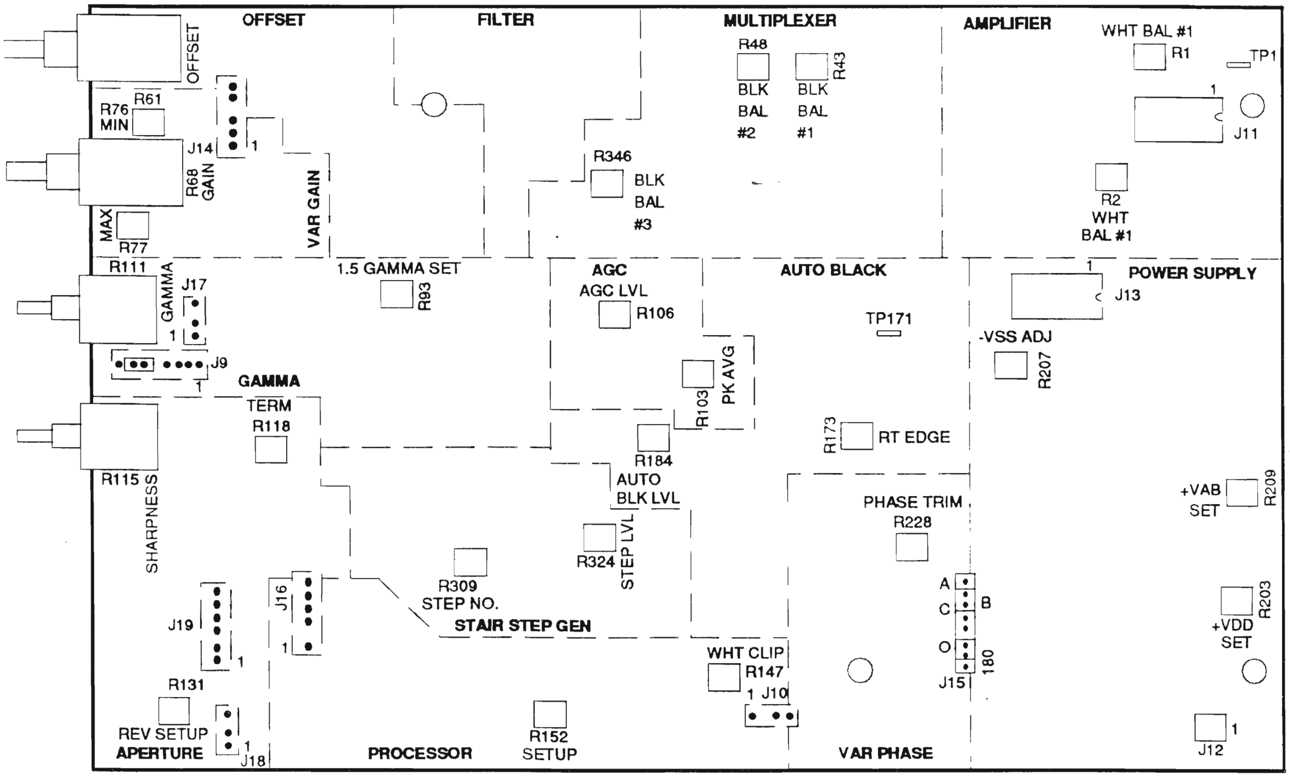


Figure 5-3. Adjustments and Test Points, Video/Auto/P.S. Board

5.4.4 Stairstep Generator Adjustment

The stairstep generator produces a test signal that is activated by setting the front panel **Auto Black** switch to **Test**. This switches out the video signal path and in its place provides the stairstep signal. Proceed as follows:

1. Set the front panel **Auto Black** switch to **Test**.

2. Observe the video output at the horizontal rate.

> **NOTE**
>
> *One IRE unit is equal to 7.14 mV. Thus 100 IRE units is equal to 714 mV. Throughout these adjustment procedures, the IRE units will be referred to only as units. The IRE will not be repeated each time. Also, video levels specified in the procedures do not include the 40 units of sync—if sync is present in the signal (See fig. 2-2 for an RS-170 video waveform.)*

3. Adjust step level (R324) to obtain 100 units.

4. Adjust Step No. (R309) to make the step at blanking level the same width as the other steps.

5. Verify that sync amplitude is 40 units.

6. Proceed to section 5.4.5, the black window adjustment.

5.4.5 Black Window Adjustment

The black window adjustment sets the window generator (U19) so black level is monitored only during active time of the video lines. That is, the window is opened only after H. blanking ends and then closed again before H. blanking begins at end of line. Lines immediately before and after vertical blanking are completely windowed out. Proceed as follows:

1. Connect the oscilloscope to TP-171 (U19-12).

2. Sync to line rate.

Table 5-4. Adjustments and Test Points, Sync/Genlock Board (A3)

REFERENCE DESIGNATION	FUNCTIONAL NAME	CIRCUIT FUNCTION
C7	Crystal Oscillator Adj	Sets frequency
C17	PLL Oscillator Adj.	Tunes PLL oscillator tank so that varactor is at nominal voltage when oscillator is on frequency
R35	2 Line V. Phase	Adjusts vertical sync when the sync reference input is H and V drive
R38	Horizontal Phase	Shifts sync in video output so it can be made coincident with a reference sync
R39	1 Line V. Phase	Adjusts V. phase when sync reference input is composite video or composite sync
R72	Shutter 1	Sets integration time for the 1/1000 second (Low) mode
R79	Clear 2	In shutter circuit, adjusts the pair of clearing pulses occuring just before vertical blanking
R87	Shutter 2	Sets integration time for the 1/2000 second (High) mode
	JUMPERS	
—	V.D. - Pregrab Position	Establishes whether the pregrab pulse leading edge is coincident with the trailing edge of the integration pulse or with the leading edge of the first vertical drive pulse following the integration pulse trailing edge. See figure 2-6.
—	Crystal - Linelock	Determines whether the default sync reference is the internal crystal oscillator or the ac power line (linelock). Applying any external sync reference "captures" the camera sync and turns off crystal or linelock.
	TEST POINTS	
TP11	Varactor voltage	Used to set varactor voltage for the phase locked loop oscillator to mid range
TP51	X Out	Oscillator output from the sync IC (U51)

Table 5-4. Adjustments and Test Points, Sync/Genlock Board (A3) (Continued)

REFERENCE DESIGNATION	FUNCTIONAL NAME	CIRCUIT FUNCTION
TP72	Clear-2 Pulse	A test point to view the one of the two pulses that clears the sensor just before vertical blanking. Not used for adjustments
TP GND	Ground test point	Board ground

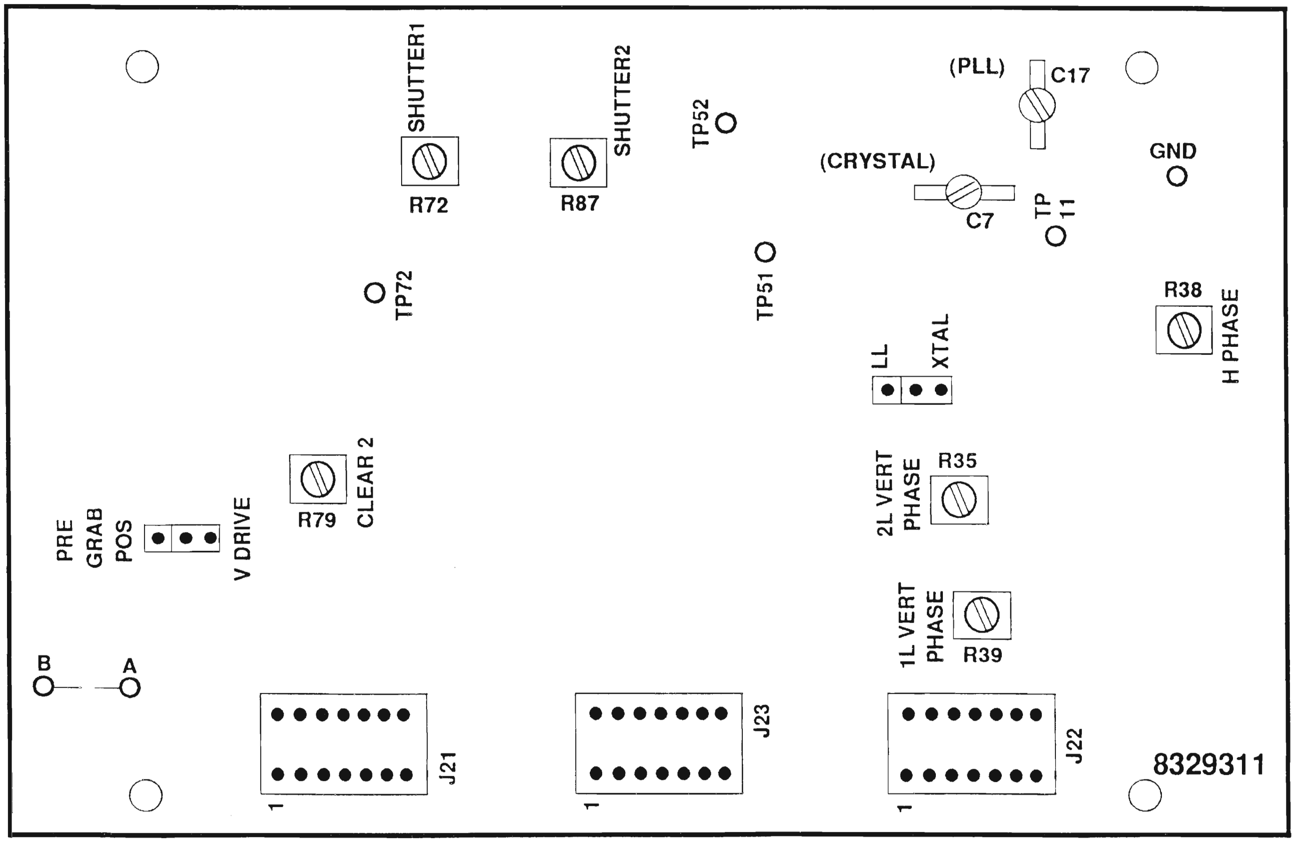


Figure 5-4. Adjustments and Test Points, Sync/Genlock Board

Table 5-5. Adjustments, Driver Board (A2)

REFERENCE DESIGNATION	FUNCTIONAL NAME	CIRCUIT FUNCTION
R15	Intg Level	Sets integrating voltage level at the parallel driver IC (U11) on the driver board in the Camera Head

Table 5-6. Power Supply Adjustments

VOLTAGE NAME	MEASURE AT	ADJUST POT.	VERIFY/ OBTAIN
+VDD	J11-13	R203	+11.6 V dc
+VAB	J11-1	R209	+5 V dc
-VSS	J13-8	R207	-9.5 V dc
+V	J11-4	—	2±0.1 V dc
+5V	J13-11	—	5±0.25 V dc
-8V	U204	—	-8±0.4 V dc
-11V	U208	—	-11±0.55 V dc

3. Adjust Right Edge (R173) to set the trailing edge of the window 2 microseconds before horizontal blanking starts.

4. Proceed to section 5.4.6, the video multiplexer balance adjustment.

5.4.6 Video Multiplexer Balance Adjustments

The three video channels at the CCU input must have equal gain and black level. This procedure uses one channel as the reference channel and then sets the other two channels to the reference channel levels. Balancing channels in this manner will optimize picture quality and eliminate vertical bars from the video. These adjustments will be repeated in section 5.4.21 during final touchup. Proceed as follows:

1. Set the front panel **Auto Black** switch to **Off.**

2. Adjust the lens f/stop to obtain about 100 units of video.

3. Adjust BLK BAL 1 (R43) and BLK BAL 2 (R48) to null the carrier at the blackest portion of the signal, as observed on the oscilloscope at the video output.

4. Adjust SETUP (R152) to obtain 7.5 units of black at the blackest portion of the signal.

5. Repeat steps 3 and 4 to optimize balance and black level, then continue to step 6.

6. Adjust WHT BAL 1 (R1) and WHT BAL 2 (R2) to null the carrier on the whitest portion of the video signal.

7. Repeat steps 2 through 6 to optimize all conditions. Then proceed to section 5.4.7, the manual gain limits adjustments.

5.4.7 Manual Gain Limits Adjustment

Minimum and maximum range of the front panel **GAIN** control is set by two potentiometers on the video circuit board. This procedure establishes these limits. The control is only active when the **Auto/Manual** switch is in **Manual.** Proceed as follows:

1. Set the front panel **GAIN Auto Manual** switch to **Manual.**

2. Set the front panel **GAIN** control fully ccw.

3. Connect the oscilloscope to the collector of Q2.

4. Set the lens iris to obtain 0.7 V p-p.

5. Adjust the MIN gain potentiometer (R76) to obtain 100 units of video at the output of the CCU.

6. Insert 1 ND (Neutral Density) in the light path.

7. Set the front panel **GAIN** control fully cw.

8. Adjust the MAX gain potentiometer (R77) to obtain 100 units of video at the output of the CCU.

9. Repeat steps 2 through 8 until no further interaction is observed. Then proceed to section 5.4.8.

5.4.8 Auto Black Adjustment

This adjustment sets the automatic black level circuit to maintain the blackest portion of the scene at 7.5 units. For this circuit to be properly set up the scene must have at least 10% black. The auto black circuit maintains contrast in scenes with little black or dark gray in them. Proceed as follows:

1. Set the front panel **Auto Black** switch to **AUTO**.

2. Adjust AUTO BLK LVL (R184) to place the blackest part of the picture at 7.5 units.

3. Proceed to section 5.4.9, the agc level adjustment.

5.4.9 Agc level Adjustment

When the **GAIN** switch is in **Manual**, the related front panel control knob provides an additional 20 dB of gain when fully cw. Using this additional gain results in an increase in noise, so the control should be left fully ccw when possible.

When the **GAIN** switch is set to **Auto** (agc), the additional 20 dB of gain is available as agc. This procedure sets the agc characteristic so gain is increased only when light level on the sensor faceplate drops below the level required to produce 100 units of video output. The agc circuit is adjusted to hold video output at 90 units as the light level decreases. The agc range is 20 dB. When this additional gain is being used, some increase in noise may be noticed in the video, just as when additional gain is used in the **Manual** mode.

Proceed as follows:

1. Set the lens iris to obtain about 100 units.

2. Insert 1 ND in front of the lens.

3. Set the front panel **GAIN** switch to **AUTO**.

4. Set AGC LVL (R106) to bring the video back to 90 units.

5. Proceed to section 5.4.10, the manual offset potentiometer range test.

5.4.10 Manual Offset Potentiometer Range Test

There are no internal board adjustments for this circuit. This procedure serves only as a performance test.

When the **Preset/Manual OFFSET** switch is set to **Manual**, the **OFFSET** control can shift the video envelope (white through black peaks, see figure 2-2) up 5 units (fully ccw) or down 85 units (fully cw).

Rotating the control cw moves the black portions of video below setup level into blanking.

The white levels remaining above setup then remain as the video signal. This signal can be expanded to increase the output, but full 1 V p-p video may not be available

This is because the video envelope can be moved down 85 units (38 dB) but only 20 dB of additional gain is available. (Either agc or manual gain control can be used to increase gain if desired.) Thus, full video output may not be available using only internal Camera gain. However the lens iris could be opened to provide more light on the sensor faceplate.

Using the **OFFSET** control in this manner makes it possible to concentrate on white areas of the scene for viewing.

Proceed as follows:

1. Rotate the front panel **OFFSET** control fully ccw.

2. Set the front panel **GAIN** switch to **Manual.**

3. Set the lens iris to obtain 100 units of video.

4. Rotate the front panel **OFFSET** control fully cw.

5. Verify that the video is moved 85 units into the blanking.

6. Proceed to section 5.4.11, the aperture circuit adjustment.

5.4.11 Aperture Circuit Adjustment

The aperture circuit can provide better rise/fall times on black-white and white-black (high frequency) transitions in the video signal. This sharpens these edges for viewing on the tv monitor. Overshoot is introduced to provide this effect. When the front panel **SHARPNESS** control is rotated cw, up to 6 dB of overshoot can be introduced for 6-MHz video.

Note: An internally adjustable potentiometer (R118, 1000 ohm, part number 5010220-102) was removed after the initial production run of this camera. It is not listed, shown, or mentioned anywhere else in the manual. The potentiometer was labeled "TERM" (for termination) in the Aperture area of the video circuit board—behind the sharpness control (R115). If the camera has potentiometer R118, start with step 1. Otherwise, proceed to step 4:

1. Set the front panel **Power** switch down to off.

2. Connect an ohmmeter between U14-2 and U14-12.

3. Adjust TERM (R118) for an indication of 470 ohms on the meter. Remove the meter.

4. Set the front panel **Power** switch up to **On**.

5. View the resolution chart.

6. Set the lens iris to obtain 100 units of video.

7. Rotate the front panel **SHARPNESS** control cw and note an improvement in the resolution wedge.

8. Rotate the control fully ccw.

9. Proceed to section 5.4.12, the gamma correction adjustment.

5.4.12 Gamma Correction Adjustment

When gamma correction is applied, the video response of the camera is no longer linear. A gamma of 0.5 stretches the blacks and compresses the whites. A gamma of 1.5 compresses the blacks and stretches the whites. (Overall peak to peak video level should not change when gamma correction is applied.) A gamma of 1.0 leaves the camera video linear. Proceed as follows:

1. Set the front panel **GAMMA** switch to **0.5 - 1.0**.

2. Set the front panel **Auto Black** switch to **Test**.

3. Rotating the **GAMMA** control cw should provide a stretching of blacks and a compression of whites. Maximum white level should remain at the 100-unit level.

4. Set the front panel **GAMMA** switch to **1.0 - 1.5**.

5. Rotate the **GAMMA** control fully ccw.

6. Set the lens iris to obtain 100 units of video.

7. Adjust 1.5 GAMMA SET (R93) so the video remains at 100 units when rotating the front panel **GAMMA** control throughout its range.

8. Verify that rotating the **GAMMA** control cw compresses the blacks and expands the whites. Leave **GAMMA** fully cw.

9. Proceed to section 5.4.13.

5.4.13 Reverse Video Adjustment

When the front panel **Video** switch is positioned up to the **Negative** position, whites and blacks are inverted in the video. To re-establish setup at 7.5 units for the inverted video envelope, an additional setup potentiometer (REV SETUP, R131) is switched into the video signal path. This potentiometer is in addition to the regular setup potentiometer (R152), which remains in the circuit.

Proceed as follows to adjust the reverse setup potentiometer:

1. Set the front panel **Video** switch up to **Negative**.

2. Set the front panel **Auto Black** switch down to **Off**.

3. Cap the lens so that no light enters the sensor.

4. Adjust REV SETUP (R131) to place the blackest (inverted white) portion of the signal at 7.5 units.

5. Set the front panel **VIDEO NEGATIVE** switch down for normal white positive video.

6. Proceed to section 5.4.14, the sensor optimization adjustments.

5.4.14 Sensor Optimization Adjustments

Some of the adjustments previously made were preliminary. These must now be readjusted in conjunction with the sensor in the camera head to obtain optimum performance. Proceed as follows:

1. Set the front panel **GAIN** switch to **Manual**.

2. Set the front panel **Auto Black** switch to **Off**.

3. Cap the lens so that no light enters the sensor.

4. Adjust SETUP (R152) to obtain 7.5 units of setup.

5. Set the oscilloscope to delayed sweep mode and view one line on a black to white transition.

6. Set +VAB SET (R209) fully ccw.

7. Set integration level (R15) on the camera head driver board fully ccw.

8. Connect the voltmeter probe to the output of U205 (-VSS).

9. Set -VSS (R207) to obtain -9.0 V dc at U205.

10. View a black-to-white transition.

11. Open the lens iris until the waveform at the collector of Q2 is at 90 percent of saturation (just below clipping).

12. Record this level. Calculate 30 percent of it for use in step 13.

13. Adjust +VAB (R209) to obtain at Q2 the 30-percent level calculated in the previous step.

14. Record this level. Calculate twice its value for use in step 15.

15. Adjust integrating level (R15) on the camera head driver board to obtain at Q2 the two-times level calculated in the previous step.

16. Set the lens iris to obtain 0.7 V p-p at Q2-C.

17. Adjust the front panel **GAIN** control to obtain 100 units of video at the output of the CCU.

18. Adjust -VSS (R207) between having vertical lines in the picture and a loss of fine detail.

19. Open the lens iris far enough to ensure that clipping does not occur below 110 units.

20. Open and close the lens iris at a high video level and verify that no vertical smearing appears on the monitor picture.

21. Adjust -VSS (R207) slightly, if necessary, to optimize elimination of smearing and loss of fine detail.

22. Set the front panel **Auto Black** switch to **Auto**.

23. Open the lens iris so that there is at least 125 units of video.

24. Adjust WHT CLIP (R147) to clip the video at 120 units. This is a typical setting. Other settings could be used.

24. Proceed to the shutter adjustment.

5.4.15 Shutter Adjustment

The shutter circuit, when activated, causes the sensor to transfer the charge integrating on its surface down into storage after 1/1000 or 1/2000 second for each field. (Each field in normally allowed to integrate on the sensor for 1/60 second.)

NOTE

Misadjustment of the shutter 1 potentiometer (R72) can cause poor interlace. This can occur with the **Shutter** *switch in any position—***Off**, **High** *or* **Low**. *Stairsteps on test pattern lines angling up or down the picture monitor screen are an indication of poor interlace.*

NOTE

The 1 ms and 500 µs (0.5 ms) settings specified in this procedure provide 1/1000 second and 1/2000 second of integration before light on the sensor is transferred into storage for readout. These potentiometers can be set for more or less integration times, in each case. But increasing beyond 1/1000 second soon goes into the active lines at the top of the picture and reducing integration below 0.5 ms may lead to smearing of the picture. Thus the 1 ms and 0.5 ms integration periods are the only recommended settings.

To adjust the shutter circuit, proceed as follows:

1. Set the front panel **Shutter** switch to **Low** (1/1000 second)

2. Connect the oscilloscope probe to U52-7 (PI) and view the vertical interval.

3. Adjust CLEAR 2 (R79) so the double pulses at the end of the field are as close together as possible but still remain as two pulses.

4. Set SHUTTER1 (R72) so the time between the end of the last double pulse and the beginning of the pulse at about line 15 is 1 ms—and the monitor picture remains stable.

5. Set the front panel **Shutter** switch to **High**.

6. Adjust SHUTTER2 (R87) so the time between the end of the last double pulse and the beginning of the pulse at about line 7 is 500 µs.

7. Change the front panel **Shutter** switch to **Off**, **Low**, and **High** while observing for proper interlace at each position.

8. Adjust slightly, if required, SHUTTER1 (R72) to obtain perfect interlace at all three switch positions.

9. Proceed to section 5.4.16, genlock adjustments.

5.4.16 Genlock Adjustment

A camera can have any one of several reference modes for the sync circuit:

- Composite video
- Composite sync
- H & V drive
- Line lock
- Internal crystal

The first three are externally applied to the rear panel of the CCU, the line lock is derived from the ac power, and the internal crystal is a circuit on the sync/genlock board.

This procedure adjusts the genlock portion of these circuits (composite video or composite sync).

1. Connect a composite video signal to SYNC/H. DRIVE connector (BNC, J3) on the rear panel of the CCU.

2. Connect a voltmeter to TP11 (2 V dc) on the genlock board.

3. Adjust oscillator trimmer capacitor C17 to obtain 2.0 V dc at TP11.

4. View the input genlock video and the CCU output video from the VIDEO output BNC connector on a dual channel oscilloscope.

5. Adjust H PHASE (R38), on the genlock board, so leading edges of horizontal sync are coincident.

6. Connect one oscilloscope channel to the genlock input and the other channel to video output.

7. Adjust 1L VERT PHASE (R39) so the vertical intervals are coincidental and the picture at the top of the monitor does not have any flag waving.

8. Proceed to section 5.4.17, the H and V drive adjustments.

5.4.17 H and V Drive Adjustments

This procedure adjusts the horizontal and vertical drive portion of the sync reference circuits. Proceed as follows:

1. Connect horizontal drive to the CCU rear panel SYNC/H DRIVE connector (J3). Level should be 0.2 to 4 V p-p.

2. Connect the vertical drive (0.2 to 4 V p-p) to the V. DRIVE connector (J2).

3. Connect one channel of the oscilloscope to the V drive input and the other to the CCU video output.

4. Adjust 2L VERT PHASE (R35), on the sync board, so the vertical intervals are coincidental and there is no flag waving at the top of the monitor picture.

5. Apply 524 line rate H and V drive to the inputs.

6. Adjust, slightly, 2L VERT PHASE (R35) so the following conditions are met simultaneously:

- Incoming vertical sync pulse leads the camera vertical sync pulse by one-half line
- Vertical sync contains six broad pulses
- No flag waving is present at the top of the monitor picture

7. Change H and V drive back to a 525-line rate

8. Verify that the incoming vertical interval and the camera vertical interval are coincident.

9. Change H and V drive to the 524 line rate and verify the three conditions listed in step 6.

10. Proceed to section 5.4.18, sync signal verifications.

5.4.18 Output Sync/Genlock Signal Verifications

This procedure does not make any adjustments. It serves only as a performance test on several of the sync-related outputs from the CCU rear panel auxiliary connector. Proceed as follows:

1. Verify a H. trigger output at J34-1.

2. Verify a V. trigger output at J34-8.

3. Verify a pixel clock output at J34-5 (4.77 MHz).

4. Proceed to section 5.4.19, the integration test.

5.4.19 Integration Test

Proper testing of the integration circuit requires a computer controlled frame grabber for digital storage of the image. The test given here is a basic procedure to determine whether the integration circuit appears to be working. Grounding the integration input on the CCU rear panel auxiliary connector initiates integration. The video output is turned off. When the ground is removed, a single frame of integrated video is produced. Subsequent frames are normal video again.

The first frame observed upon release of the ground should have increased brightness (or bloom if integration was maintained too long). Even with the lens stopped down and an ND filter in front, integration will soon produce blooming. This is because integration is occurring at a rate of 60 fields per second, a field every 16.6 milliseconds.

Proceed as follows to perform a brief functional test of integration:

1. Remove external sync inputs.

2. Set the front panel **GAIN** switch to **Manual.**

3. Set the front panel **Shutter** switch to **Off**

4. Stop down the lens iris completely.

5. Add ND filters in front of the lens.

6. Sync the oscilloscope and/or waveform monitor to the video.

7. Ground (or pull low) pin 7 of the CCU auxiliary connector for a fractional second. Repeat as necessary for step 8.

8. Observe that upon release of the ground (or low state) on the integration input, a single field of video is produced with increased brightness.

9. Proceed to section 5.4.20, optimization adjustments.

5.4.20 Optimization Adjustments

The preceding adjustments established that the camera and all its adjustments are operating correctly. Sections 5.4.21 through 5.4.23 provide final settings to several of the adjustments and then test camera performance to verify proper operation before releasing it for use. Proceed to section 5.4.21.

5.4.21 Channel Gain Balance

> **NOTE**
>
> *The crystal/linelock (XTAL/LL) jumper must be positioned to the desired default sync reference mode before making these final adjustments.*

A final adjustment must be performed on the black and white balance potentiometers. These adjustments must be performed if the crystal/linelock jumper is repositioned in the future.

Be sure the jumper is in the desired position before starting this procedure. Proceed as follows:

1. Position the crystal/linelock jumper to the final operating position intended for the camera.

2. Set the **Auto Manual GAIN** switch to **Auto**.

3. Reduce light level to obtain about 80 units.

4. Adjust BLK BAL #1 (R43) and BLK BAL #2 (R48) to minimize interference in the black areas.

5. Adjust WHT BAL #1 (R1) and WHT BAL #2 (R2) to minimize interference in white and gray areas.

6. Proceed to section 5.4.22, manual black level clamp adjustment.

5.4.22 Manual Black Level Clamp Adjustment

This procedure adjusts to hold setup level at 7.5 units with both normal gain and with 20 dB gain. Proceed as follows:

1. Set front panel controls as follows:

•**OFFSET** switch . . . . . . **Preset.**
•**GAIN** switch . . . . . . **Manual**
•**GAIN** . . . . fully ccw
•**GAMMA** . . . . fully cw (1)
•**Auto Black** switch . . . . . **Off**

2. Cap the lens.

3. Adjust SETUP (R152) to obtain 7.5 units of black.

4. Rotate **Manual GAIN** full cw while observing black level.

5. Adjust, if required, BLK BAL #3 (R346) to set black level to 7.5 units. Do not readjust R346 for 7.5 units after the lens is uncapped.

6. Uncap the lens.

7. Set the **AUTO BLACK** switch up to **AUTO BLACK** on.

8. Adjust AUTO BLACK LVL (R184) to obtain 7.5 units.

9. Proceed to section 5.4.23, lens back-focus adjustment.

5.4.23 Lens Back-focus Adjustment

Spacing is critical between the rear element of a lens and the sensor. If the lens is too close or too far from the sensor, proper focus will not be possible at some (or any) focus ring settings.

This back-focus distance is determined empirically. By rotating the lens and C-mount adapter as a pair in and out of the camera lens well, focus can be observing while viewing on the tv monitor. When best focus is obtained the C-mount adapter is locked into place by snugging down a setscrew.

This procedure assumes the Camera Head is on a Camera test jig pointing at a test pattern. The collimator must be positioned on the test jig in front of the test pattern. If a collimator lens is not available, point the Camera head at a distant scene containing details on which to observe for sharp focus.

Proceed as follows:

1. Install the collimator lens assembly on the Camera test jig in front of the test pattern. Push it up against the light box so that the calibrated rods are touching the box.

2. Open the lens iris fully and add enough Neutral Density (ND) filters in front of the lens to reduce the video level to about 100 units (714 mV).

3. Screw the lens and C-mount snugly together.

4. Set the lens at infinity focus.

5. Loosen the setscrew (5/64 in. Allen wrench).

6. Rotate the lens and C-mount as a unit to obtain sharp focus.

7. Snug down the C-mount setscrew.

8. Proceed to section 5.5, performance verifications.

5.5 PERFORMANCE VERIFICATION

These tests determine whether the camera is operating properly. They should performed after the adjustments in section 5.4 are completed. They can also be performed anytime it is necessary to determine whether the camera is operating properly.

5.5.1 Sensitivity and Resolution Tests

Accurately testing sensitivity can be difficult. The light source must not only be of the required intensity level but also at proper color temperature. Using the Camera Test Jig specified, the following procedure gives a reasonable determination of Camera sensitivity. The fluorescent lamps in the test jig light box should be relatively new. As lamps age with use, their light output declines. For greater accuracy, use the light meter specified in the table 5-1, recommended test equipment, to determine actual light level at the test pattern.

Proceed as follows:

1. Place the resolution test pattern in front of the camera test jig light box.

2. Set the lens iris to f/8

3. Place 1 ND in front of the lens.

4. Set the CCU front panel **GAIN** switch to **Manual.**

5. Rotate the **GAIN** control fully ccw.

6. Verify a video output level of 100 units.

7. Set the front panel **GAIN** switch to **Auto**.

8. Add 2 ND (total 3 ND) in front of the lens.

9. Verify 90 units of video output.

10. Remove all the ND filters.

11. Adjust the iris to obtain 100 units of video.

12. Proceed to section 5.5.2, the resolution test.

5.5.2 Resolution and Blemish Tests

Use the camera test jig resolution chart to determine line resolution. Swing the chart out of the way and use the translucent screen on the light box to check for any dust or other foreign objects in the camera light path.

Proceed as follows:

1. Examine the picture for a horizontal resolution of 560 lines.

2. Examine the picture for a vertical resolution of 350 lines.

3. Remove the resolution chart so that only a clean white background is in the scene.

4. Set the lens to f/16

5. Set the **GAIN** switch to **Auto.**

6. Verify that no dust or dirt is present in the optics light path.

7. Cap the lens.

8. Examine the picture to verify that no picture element blemishes exist.

9. Proceed to section 5.5.3, the power line regulation test.

5.5.3 Power Line Regulation Test

This test requires that the CCU line cord be plugged into an adjustable power autotransformer, such as a Variac. Proceed as follows:

1. Connect the line cord to a power autotransformer set for 115 V ac.

2. Verify that the camera is operating.

3. Set the autotransformer to provide 105 V ac.

4. Perform the tests of sections 5.5.1 and 5.5.2.

5. Set the autotransformer to provide 125 V ac.

6. Perform the tests of sections 5.5.1 and 5.5.2.

7. Set the transformer to provide 115 V ac.

8. Proceed to section 5.5.4, the auto white and black tests.

5.5.4 Auto White and Auto Black Test

Perform these tests to verify that the automatic circuits maintain black level at the proper level with varying video conditions. These tests also verify that the agc circuit maintains video level at 90% through a 20 dB range. Proceed as follows:

1. Cap the lens.

2. Switch **GAIN** between **Auto** and **Manual** while observing black level on the waveform monitor.

3. Verify that black level is maintained at 7.5±5 units.

4. Uncap the lens and view the resolution chart.

5. Reduce light level by three f/stops.

6. Set the **GAIN** switch to **Auto**.

7. Verify that the agc circuit returns video to 90 units (90% video).

8. Proceed to section 5.5.5, the shutter test.

5.5.5 Shutter Test

When the shutter is turned on, an additional 4 (1/1000 s) or 5 (1/2000 s) f/stops of light is required to produce full video output. This procedure tests the circuit using this fact. Proceed as follows:

1. Set the **GAIN** switch to **Manual**

2. Rotate the **GAIN** control fully ccw.

3. Set the lens iris to obtain about 100 units of video.

4. Set the **Shutter** switch to **Low** (1/1000 s).

5. Open the iris four f/stops.

6. Verify that video returns to 100 units, that interlace remains good, and that no jitter is present.

7. Set the **Shutter** switch to **High** (1/2000 s).

8. Open the iris an additional f/stop (5 total).

9. Verify that video returns to 100 units, that interlace remains good, and that no jitter is present.

10. Set the **Shutter** switch to **Off**.

11. Proceed to section 5.5.6, the genlock test.

5.5.6 Genlock Test

This performance test determines not only whether the camera locks up to an externally applied sync signal, but whether it also maintains interlace and other picture characteristics. Proceed as follows:

1. Apply an RS-170 composite video signal to the CCU rear panel SYNC/H. DRIVE input (BNC)

2. Verify that the camera locks up at both the horizontal and the vertical rate and that no flag waving is present at the top of the picture monitor.

3. Apply a horizontal drive signal to the SYNC/H. DRIVE input and a vertical drive signal to the V. DRIVE input.

4. Verify that the camera locks up at both the horizontal and the vertical rate and that no flag waving is present at the top of the picture monitor.

5.5.7 Completion and Release

1. Turn off the Camera.

2. Verify that all jumpers are positioned to the required conditions for the intended use. If the XTAL/LINELOCK jumper is now moved, the balance adjustments will have to be done again. The PEAK/AVG potentiometer should be at midrange unless the setting for field conditions is to be made.

3. Proceed to section 5.5.8, the mechanical tests.

5.5.8 Mechanical Tests.

1. Inspect all screws inside the CCU and camera head to verify that they are properly snugged down.

2. Check all repositionable jumpers and the connectors to verify that they are completely seated or engaged.

3. Install the covers on the CCU and camera head.

4. Reconnect the test equipment for a functional test.

5. Apply power to the Camera.

6. Perform a functional test to verify proper operation.

7. Release the Camera for service.

5.6 SUBASSEMBLY REMOVAL, REPAIR, AND REPLACEMENT

This section contains procedures for the removal and replacement of all circuit boards in the Camera.

CAUTION

Use appropriate static discharge control methods when handling the Camera or any of its circuit boards. The small size of the surface mount components and the presence of CMOS devices makes it important to take all standard precautions.

CAUTION

Do not attempt repair of these circuit boards unless proper equipment and trained operators are available to work with surface mount technology.

5.6.1 Camera Head Cover Removal

A single adjustment (R15) is located inside the Camera Head. This makes it necessary to remove the cover during setup adjustments. Proceed as follows to remove the cover from the Camera Head:

1. Turn off power at the CCU.

2. Remove the two rear-panel screws on the Camera Head.

3. Slide the cover straight to the rear to remove it.

5.6.2 Camera Head Cover Installation

1. Turn off power at the CCU.

2. Slide the cover onto the Camera Head.

3. Install the two rear-panel screws.

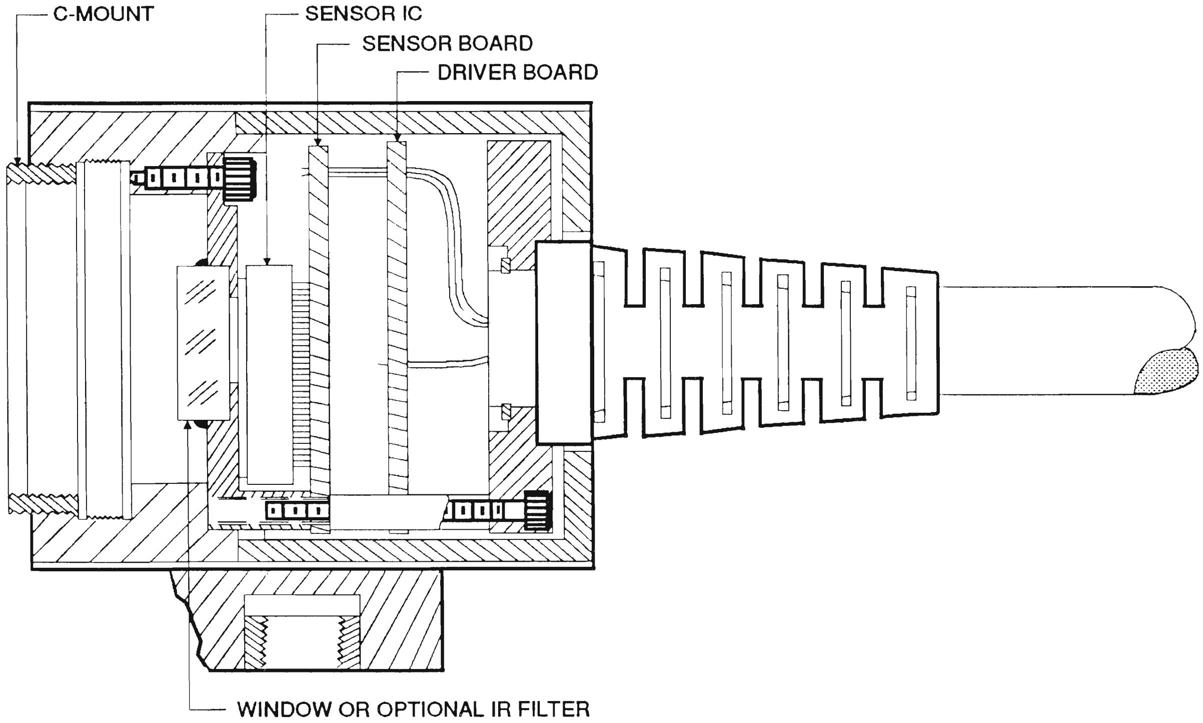


Figure 5-5. Cutting Plane, Camera Head

CAUTION

Do not attempt the Camera Head circuit board removal and installation procedures without special equipment and training. A properly equipped work station and trained operator are necessary for any soldering on a surface mount circuit board.

5.6.3 Sensor and Driver Boards Removal

Refer to figure 5-5 for a cutting-plane (side) view of the Camera Head.

1. Remove the Camera Head cover, as described in section 5.6.1.

2. Remove the three hex (Allen) screws.

3. Move the rear casting (gently) to the rear, being careful not to break off any wires.

4. Remove the three standoffs, using long nose pliers to grasp them and turn.

5. Move the pair of circuit boards gently to the rear, being careful not to break any wires.

6. Separate the boards, if desired, by unplugging them from each other.

7. Unsolder the wires from the boards.

5.6.4 Sensor and Driver Board Installation

1. Place the window into the front casting. (Thoroughly clean first.)

2. Install the O-ring.

3. Install the retaining ring.

4. Use dry nitrogen or air to thoroughly blow out all dust and other contaminants from the window and surrounding area inside the casting.

3. Solder the wires to the boards.

4. Plug the two boards together.

5. Thoroughly clean the sensor faceplate.

6. Set the sensor into the well behind the window, being certain that no dust or other contaminant is present. This is a focal plane area. Any foreign object in the light path will appear in the scene.

7. Install the three standoffs, using long-nose pliers to grasp and turn them. Do not over tighten. These are No. 2 screws, which easily can be twisted off.

8. Set the rear casting in place.

9. Install the three hex head screws.

10. Perform Camera setup adjustments before installing the Camera Head cover.

5.6.5 CCU Case Removal

CAUTION

The CCU contains sensitive devices that can be damaged by static discharge. Use appropriate static control methods when working inside the chassis or at connector pins when cables plugs are removed.

1. Turn off power and unplug the line cord.

2. Remove the two screws on each side of the case.

3. Lift the case off the chassis and place in a location where it will not be scratched or otherwise damaged.

5.6.6 CCU Case Installation

1. Place the case on the chassis and align the two holes on each side.

2. Install the two screws on each side.

3. Proceed to any other required task.

5.6.7 Sync/Genlock Board Removal

The sync/genlock board sits on standoffs above the video board. It is hinged on the two rear standoffs and held down on the front two. To remove this board, proceed as follows:

1. Remove the CCU case, as described in section 5.6.5.

2. Remove the two screws holding the board to the two front standoffs.

3. Tilt the board up and disconnect the following plugs. (References in parenthesis indicate where the related cables route to.)

•P21 (Rear panel—Camera Head)
•P23 (Video board)
•P24.(Front panel—Shutter)

5. Remove the two screws holding the sync/genlock board to the hinges on the standoffs.

6. Lift the board out of the CCU chassis and place in a static protective bag.

7. Proceed to any other required tasks.

5.6.8 Sync/Genlock Board Installation

1. Remove the board from its static protective bag.

2. Set the board into place on the hinged standoffs, component side down and with the three sets of soldered pins to the rear..

3. Install the two screws at the hinges.

4. Connect the following plugs:

•P21 (Rear panel—Camera Head)
•P23 (Video board)
•P24(Front panel—Shutter)

5. Position the board down onto the front standoffs and install the two screws.

6. Proceed to any other required tasks.

5.6.9 Video Board Removal

1. Remove the sync/genlock board, as described in section 5.6.7. (The P13/P23 cable is assumed to be unplugged at the video board so that it remains connected to the sync/genlock board.)

2. Disconnect the following plugs on the video board, which interconnect with the front panel:

•P14 (Gain and Offset)
•P16 (Auto Black)
•P17 (Gamma)
•P19 (Video Negative)
•P18 (Power lamp)

3. Disconnect the following plugs on the video board (which interconnect with the rear panel:

•P10 (Video)
•P34 (Auxiliary/H.Trig/V.Trig)

4. Remove the four standoffs.

5. Remove the front panel **OFFSET** and **GAIN** multiturn counting dials Use a No. 2 (0.048 inch) four-flute spline wrench.

6. Remove the front panel **Gamma** and **Sharpness** knobs.

7. Remove the nuts from the four potentiometer shafts on the front panel. (Note that the two shafts for the counting dials have a keying ring behind the nut.)

8. Remove the two screws holding the rear of the board to the chassis.

9. Slide the board slightly to the rear and lift out of the chassis.

10. Place in a static protective bag.

11. Tape the insulating fish paper in place or remove it and store in a safe place until required for reinstallation.

12. Proceed to any other required tasks.

5.6.10 Video Board Installation

1. Inspect the insulating fish paper. If it is damaged, replace before continuing with the board installation.

2. Install the insulating paper on the CCU chassis rails.

3. Remove the board from its static protective bag.

4. Place the board onto the standoffs in the chassis, with control shafts of the potentiometers passing through the front panel.

5. Install the following—but do not tighten:

a. The two rear screws

b. The four standoffs (Hinged standoffs toward the back.)

c. The four potentiometer nuts. (Use the keying rings on the **OFFSET** and **GAIN** shafts and regular flat washers on **Gamma** and **Sharpness.**)

6. Shift the board as necessary to align it with all fasteners.

7. Snug down the two rear screws and the four standoffs slightly to hold the board in place while the front panel potentiometers are fastened. (Screws and standoffs will be tightened more later.)

8. Position each keying ring so the tab is at the 5 o'clock position (**OFFSET** and **GAIN** shafts)

9. Tighten the **OFFSET** and **GAIN** shaft nuts.

10 Tighten the **Gamma** and **Sharpness** nuts.

11. Install the counting dials on the **OFFSET** and **GAIN** shafts, being sure the dial assemblies and keying tabs mate. (Position locking levers at about 1 o'clock.)

12. Install the **Gamma** and **Sharpness** knobs.

13. Tighten the two rear screws and the four standoffs. (Do not overtighten.)

14. Connect the following plugs to the video board (Related cables interconnect with the front panel):

•P14 (Gain and Offset)
•P16 (Auto Black)
•P17 (Gamma)
•P19 (Video Negative)
•P18 (Power lamp)

15. Connect the following plugs to the video board (Related cables interconnect with the rear panel):

•P10 (Video)
•P34 (Auxiliary/H.Trig/V.Trig)

17. Obtain the sync/genlock board from its static protective bag. Verify that the P13/P23 cable is with the board or available for installation in step 16.

16. Install the sync/genlock board, as described in section 5.6.8. After the board is installed, proceed to step 17.

17. Inspect the CCU to verify that all hardware is properly installed, that all cables and wires are properly positioned, and that all other facets of the circuit board installations are correct.

NOTE

Be sure a jumper is installed to connect pins 6 and 7 of J9 if an optional circuit board cable is not plugged in there.

17. Perform a functional test and the complete adjustment procedure for the camera.

5.6.11 Counting Dial Removal and Installation

The counting dial has an inner scale calibrated in hundredths of a turn; the outer scale counts the number of turns--up to 15. When used with a 10-turn potentiometer, the counting dial will stop at 10 on the outer scale.

The counting dial must be properly installed to ensure full range is available on the 10-turn potentiometer.

A No 2. (0.048 inch) four fluted spline key is required to remove and install the counting dial on a potentiometer shaft. (This key resembles a standard Allen wrench key but has a different shape. Be sure to obtain the spline type key.)

Perform steps 1 and 2 to remove a counting dial. Perform steps 3 through 10 to install a dial:

1. Insert a No. 2 (0.048 inch) four fluted spline key in the shaft setscrew and loosen it.

2. Slide the counting dial off the potentiometer shaft.

3. Install a counting dial by first rotating the related potentiometer shaft fully ccw until it is against its stop.

4. Rotate the counting dial knob until 0 (zero) appears in the window and the inner scale reads higher than 10.

5. Set the counting dial brake level full left (brake off).

6. Verify that the key of the mounting bracket is at about the 5 o'clock position. (This is the flat washer with keying arm held in place by the panel nut for the potentiometer).

7. Position the counting dial on the potentiometer shaft, with the antibacklash clip on the dial engaged on the locating lug of the mounting bracket.

8. Rotate the inner scale counterclockwise slowly until 0 (zero) of the inner dial coincides with the index mark.

9. Tighten the setscrew, using the spline wrench.

10. Rotate the dial to ensure that 10 turns are available.

11. Proceed to any other required tasks.

5.7 SUPPLEMENTARY MAINTENANCE DATA

Table 5-7 lists wiring between the Camera Head Connector (J1) and the two circuit boards, sensor (A1) and driver A2). This table can also be used as a pin function diagram for the mating connector on the CCU (J33). ###

Table 5-7. Interconnections, Camera Head Connector

FROM	TO	WIRE COLOR	FUNCTION/NAME
J1-1	A2-1	white/green	PI
J1-2	A2-2	violet	AB/INT
J1-3	A2-3	blue	GT
J1-4	A2-4	green	PS
J1-5	A1-5	white/yellow	SH3
J1-6	A1-6	yellow	SH2
J1-7	A1-7	white/black/yellow	SH1
J1-8	A2-8	orange	+VAB
J1-9	A2-9	white/black/orange	-VAB
J1-10	A2-10	white/orange	Ground
J1-11	A1-11	red	Video out 1 (red)
J1-12	Cable shield	-	Video shield
J1-13	A1-13	brown	Video out 2 (green)
J1-14	A2-14	gray	T
J1-15	A2-15	white/blue	S1
J1-16	A2-16	white	S2
J1-17	A2-17	white/violet	S3
J1-18	A2-18	white/black	PB
J1-19	A2-19	white/gray	I/N
J1-20	Cable shield	-	Cable overall shield
J1-21	A2-21	white/brown	+V
J1-22	A1-22	white/black/brown	+VDD
J1-23	A2-23	white/red	-VSS
J1-24	A1-24	white/black/red	Ground
J1-25	A1-25	black	Video out 3 (blue)
A1-12	Video shield	-	-
A2-20	Overall shield	-	-

A1 is sensor board; A2 is driver board

SECTION VI
PARTS LISTS

6.1 PARTS LIST USE

Parts appear in the reference designation order. This system of identification places assemblies and components in order by alphabetical and numeric designations. For example:

A1R21

Subassembly A1 ——┘ └——Resistor R21 of
Subassembly A1

Unused reference designations are not listed; thus, notations such as Not Used do not appear in a parts list sequence where reference designations are skipped.

Included in the parts list are electrical components (capacitors, resistors, ICs, etc.) together with closely associated parts such as connectors, IC sockets, and fuses. Mechanical parts subject to wear, damage, or loss in normal use appear in the lists, too.

All parts are identified by name and description together with a company part number. Transistors, diodes, ICs, and similar parts may also be identified by the name and part number of a particular manufacturer. Equivalent parts from other manufacturers may be substituted; however, if the designation "only" appears together with the manufacturer and part number reference, no substitution should be made. Only the exact part from that manufacturer is acceptable. In all cases, though, the company part number can be used to order the part from either the factory or from an authorized representative.

TABLE 6-1. Parts List, Model 6510 Camera Head

REF DESIG	DESCRIPTION	PART NUMBER
	From 8350001-001 issue 6	
A1	Sensor Board	8350111-001
A2	Driver Board	8350121-001
MP1	Adapter, C-mount	8350008-001
MP2	Setscrew, 8-32 x 15/64, Stainless, Nylon Tipped	2010258-001
MP3A	Glass Plate, Clear	3010075-001
MP3B	Glass Plate, IR Blocking Filter	8352001-001
MP4	Screw, Stainless, Pan Head, 2-56 x 1/8	0310044-003
MP5	Screw, Stainless, Pan Head, 2-56 x 1/8	0310044-003
MP6	Screw, Stainless, Fillister Head, 6-32 x 5/16	0310008-027
MP7	Screw, Stainless, Fillister Head, 6-32 x 5/16	0310008-027
MP8	Adapter, Mounting Plate, 1/4-20	8350011-001

Note: Either MP3A or MP3B is used, not both

Table 6-2. Parts List, Type 8350111-001 Sensor Board (A1)

REF DESIG	DESCRIPTION	PART NUMBER
	From 8350111-001 issue 4	
C1	Capacitor, Tantulum, 1 µF, ±20%, 16 V	0510169-007
C2	Capacitor, Tantulum, 1 µF, ±20%, 16 V	0510169-007
C3	Capacitor, Tantulum, 1 µF, ±20%, 16 V	0510169-007
C4	Capacitor, Tantulum, 1 µF, ±20%, 16 V	0510169-007
C5	Capacitor, Tantalum, 33 µF, ±20%, 16 V	0510169-012
C6	Capacitor, Ceramic, 0.1 µF, ±20%, 50 V	0410042-002
P12	Connector, 2-position	1710378-002
P11	Connector, 8-position	1710378-008
Q1	Transistor, PNP (Motorola MMBT3906)	7210123-002
Q2	Transistor, PNP (Motorola MMBT3906)	7210123-002
Q3	Transistor, PNP (Motorola MMBT3906)	7210123-002
R1	Resistor, Thick Film, 130 Ohm, ±5%, 1/8 W	4710043-131
R2	Resistor, Thick Film, 100 Ohm, ±5%, 1/8 W	4710043-101
R3	Resistor, Thick Film, 100 Ohm, ±5%, 1/8 W	4710043-101
R4	Resistor, Thick Film, 100 Ohm, ±5%, 1/8 W	4710043-101
U1	Sensor IC, Monochrome, 20 pin, NTSC (Part of CCD IC set)	3610361-102
U2	Three Channel Sample and Hold, 16-Pin (Part of CCD IC set)	3610329-006
U501	Sensor IC Set (Texas Instrument), consisting of U1 and U2 above plus U11 and U12 on Driver Board and U146 on Video/Sync/P.S. Board:	3610361-101
(U1)	Sensor, 1/2 inch, monochrome, NTSC (TC245-20)	(3610361-102)
(U2)	3-channel Sample and Hold (TL1593)	(3610329-006)
(U11)	Parallel Driver (TMS3473)	(3610329-005)
(U12)	Serial Driver (SN28846)	(3610348-004)
(U146)	Timing (Sync) Generator (SN28835FS)	(3610348-005)

Table 6-3. Parts List, Type 8350121-001 Driver Board (A2)

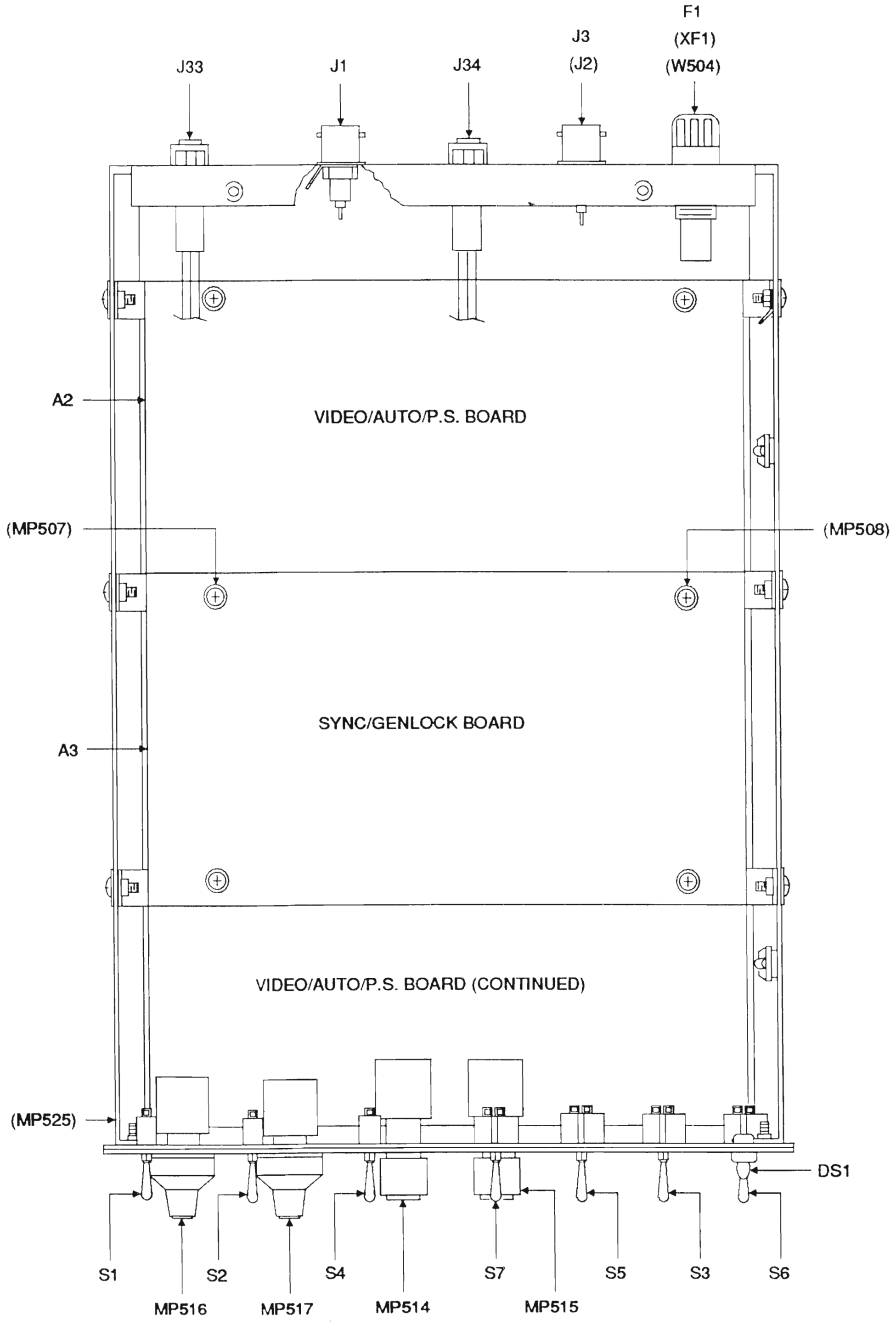
REF DESIG	DESCRIPTION	PART NUMBER
	From 8350121-001 issue 2	
C11	Capacitor, Tantalum, 4.7 µF, ±20%, 6 V	0510169-013
C12	Capacitor, Tantalum, 15 µF, ±20%, 10 V	0510169-015
C13	Capacitor, Tantalum, 47 µF, ±20%, 6 V	0510169-014
C14	Capacitor, Electrolytic, 100 µF, -20 +100%, 16 V	0510160-045
C15	Capacitor, Ceramic, NPO 0.1 µF, ±20%, 50 V	0410042-002
C16	Capacitor, Tantalum, 10 µF, ±20%, 16 V	0510169-009
C17	Capacitor, Tantalum, 15 µF, ±20%, 10 V	0510169-015
J21	Connector, 8 pin	1710363-008
J22	Connector, 2 pin	1710363-002
R15	Resistor, Variable, Side Adjust, 25 Kilohm, 10%, 1/2 W	5010230-253
R11	Resistor, Thick Film, 11 Kilohm, 5%, 1/8 W	4710043-113
R12	Resistor, Thick Film, 22 Kilohm, 5%, 1/8 W	4710043-223
R13	Resistor, Thick Film, 47 Kilohm, 5%, 1/8 W	4710043-473
R14	Resistor, Thick Film, 100 Kilohm, 5%, 1/8 W	4710043-104
U11	Parallel Driver (part of IC sensor set)	3610329-005
U12	Serial Driver (part of IC sensor set)	3610348-004

Table 6-4. Parts List, Model 6510 Camera Control Unit

REF DESIG	DESCRIPTION	PART NUMBER
	From 8329401-001 issue 3	
A2	Video/Auto/Power Supply Board	8329211-001
A3	Sync/Genlock Board	8329311-001
DS1	Lamp, Snap In, 2 Volt (Leecraft L59D-R2-W)	1710348-002
E1	Lug, Grounding (power)	2010241-202
E2	Lug, Grounding (BNC)	1710108-004
E3	Lug, Grounding (BNC)	1710108-004
E4	Lug, Grounding (BNC)	1710108-004
F1	Fuse, Time Lag, 200 mA, 250 V, MDL 2/10	1710040-009
J1	Connector, Bulkhead, BNC	1310242-001
J2	Connector, Bulkhead, BNC	1310242-001
J3	Connector, Bulkhead, BNC	1310242-001
MP501	Insulator, Fish Paper, 2 by 1.9 by 0.010 inch	8329404-001
MP502	Insulator, Fish Paper, 7.5 by 0.62 by 0.010 inch	8329409-001
MP503	Insulator, Fish Paper, 7.5 by 0.62 by 0.010 inch	8329409-001
MP504	Insulator, Fish Paper, 7.5 by 0.62 by 0.010 inch	8329409-001
MP505	Screw Lock (at J33)	1310139-101
MP506	Screw Lock (at J33)	1310139-101
MP507	Standoff, Hinged	2010497-007
MP508	Standoff, Hinged	2010497-007
MP509	Standoff, Nickle Plated Brass, 1.125 inch long	2010581-007
MP510	Standoff, Nickle Plated Brass, 1.125 inch long	2010581-007
MP511	Standoff, Nickle Plated Brass, 1.750 inch long	2010581-008
MP512	Standoff, Nickle Plated Brass, 1.750 inch long	2010581-008
MP513	Strain Relief, Line Cord	1704097-006
MP514	Knob, Black with dot (Gamma)	2010535-022
MP515	Knob, Black with dot (Sharpness)	2010535-022
MP516	Counting Dial (OFFSET)	2010689-001
MP517	Counting Dial (GAIN)	2010689-001
MP518	Key, Nylon (for P10)	1310315-151
MP519	Key, Nylon (for P14)	1310315-151
MP520	Key, Nylon (for P16)	1310315-151
MP521	Key, Nylon (for P17)	1310315-151
MP522	Key, Nylon (for P18)	1310315-151
MP523	Key, Nylon (for P19)	1310315-151
MP524	Key, Nylon (for P24)	1310315-151
MP525	Stand, Tilt	2010688-001
MP526	Cover/Case, CCU	8329505-001
P10	Connector, 4 pin	1313315-244
P12	Connector, 2 pin	1310313-222

Table 6-4. Parts List, Model 6510 Camera Control Unit (Continued)

REF DESIG	DESCRIPTION	PART NUMBER
P14	Connector, 6 pin	1310315-246
P16	Connector, 6 pin	1310315-246
P17	Connector, 4 pin	1313315-244
P18	Connector, 4 pin	1313315-244
P19	Connector, 8 pin	1310315-248
P24	Connector, 4 pin	1313315-244
S1	Switch, SPDT, (on-none-on)	6110050-024
S2	Switch, SPDT, (on-none-on)	6110050-024
S3	Switch, DPDT, (on-off-on)	6110050-027
S4	Switch, SPDT, (on-none-on)	6110050-024
S5	Switch, DPDT, (on-none-on)	6110050-025
S6	Switch, DPDT, (on-none-on)	6110050-025
S7	Switch, SPDT, (on-off-on)	6110050-026
W501	Cable Assembly (P13—P23)	7610128-002
W502	Cable Assembly (J34—P22)	7610138-001
W503	Cable Assembly (J33—P11/P21)	7610139-001
W504	Line Cord, 18/3, 8 foot, Gray (NEMA 5-15P Plug)	7610071-001
XF1	Holder, Fuse, AGC, Bulkhead (Littlefuse 342004)	1710094-003



(DESIGNATES HIDDEN PART)

Figure 6-1. Location of Components, Top View, CCU

Table 6-5. Parts List, Type 8329211-001 Video/Auto/Power Supply Board (A2)

REF DESIG	DESCRIPTION	PART NUMBER
	From 8329211-001 Issue 4	
C1	Capacitor, Electrolytic, 47 µF, 20%, 16 V	0510170-006
C2	Capacitor, Electrolytic, 47 µF, 20%, 16 V	0510170-006
C3	Capacitor, Electrolytic, 47 µF, 20%, 16 V	0510170-006
C4	Capacitor, Ceramic Disc, 0.1 µF, +80 -20%, 10 V	0410036-001
C5	Capacitor, Electrolytic, 47 µF, 20%, 16 V	0510170-006
C6	Capacitor, Electrolytic, 22 µF, 20%, 16 V	0510170-007
C7	Capacitor, Ceramic Disc, 0.1 µF, +80 -20%, 10 V	0410036-001
C11	Capacitor, Metalized Polyester, 0.22 µF, 10%, 50 V	0610165-224
C12	Capacitor, Metalized Polyester, 0.22 µF, 10%, 50 V	0610165-224
C13	Capacitor, Metalized Polyester, 0.22 µF, 10%, 50 V	0610165-224
C14	Capacitor, Tantalum, 47 F, 20%, 6 V	0510155-009
C15	Capacitor, Tantalum, 47 F, 20%, 6 V	0510155-009
C16	Capacitor, Tantalum, 47 F, 20%, 6 V	0510155-009
C21	Capacitor, Electrolytic, 47 µF, 20%, 16 V	0510170-006
C22	Capacitor, Electrolytic, 47 µF, 20%, 16 V	0510170-006
C31	Capacitor, Ceramic Disc, 0.1 µF, +80 -20%, 10 V	0410036-001
C51	Capacitor, Ceramic Disc, 0.1 µF, +80 -20%, 10 V	0410036-001
C52	Capacitor, Silver Mica, 39 pF, 10%, 300 V	1010005-390
C53	Capacitor, Silver Mica, 82 pF, 10%, 300 V	1010005-820
C54	Capacitor, Silver Mica, 82 pF, 10%, 300 V	1010005-820
C55	Capacitor, Silver Mica, 39 pF, 10%, 300 V	1010005-390
C57	Capacitor, Metalized Polyester, 0.1 µF, 10%, 50 V	0610164-104
C58	Capacitor, Ceramic Disc, 0.1 µF, +80 -20%, 10 V	0410036-001
C59	Capacitor, Ceramic Disc, 0.1 µF, +80 -20%, 10 V	0410036-001
C60	Capacitor, Silver Mica, 5 pF, 10%, 300 V	1010005-050
C61	Capacitor, Electrolytic, 47 µF, 20%, 16 V	0510170-006
C62	Capacitor, Electrolytic, 47 µF, 20%, 16 V	0510170-006
C63	Capacitor, Ceramic Disc, 0.1 µF, +80 -20%, 10 V	0410036-001
C64	Capacitor, Ceramic Disc, 0.1 µF, +80 -20%, 10 V	0410036-001
C65	Capacitor, Ceramic Disc, 0.1 µF, +80 -20%, 10 V	0410036-001
C66	Capacitor, Electrolytic, 22 µF, 20%, 16 V	0510170-007
C67	Capacitor, Electrolytic, 220 µF, -20 +75%, 16 V	0510166-929
C68	Capacitor, Ceramic Disc, 0.1 F, +80 -20%, 10 V	0410036-001
C70	Capacitor, Ceramic Disc, 68 pF, 20%, 500 V	0401018
C81	Capacitor, Metalized Polyester, 0.1 µF, 10%, 50 V	0610164-104
C82	Capacitor, Ceramic Disc, 0.1 µF, +80 -20%, 10 V	0410036-001
C83	Capacitor, Ceramic Disc, 0.1 µF, +80 -20%, 10 V	0410036-001
C85	Capacitor, Silver Mica, 2 pF, 10%, 300 V	1010005-020
C86	Capacitor, Silver Mica, 12 pF, 10%, 300 V	1010005-120

Table 6-5. Parts List, Type 8329211-001 Video/Auto/Power Supply Board (A2)(Continued)

REF DESIG	DESCRIPTION	PART NUMBER
C101	Capacitor, Metalized Polyester, 1.0 µF, 10%, 50 V	0610165-105
C111	Capacitor, Electrolytic, 47 µF, 20%, 16 V	0510170-006
C112	Capacitor, Electrolytic, 100 µF, -20 +75%, 10 V	0510166-908
C113	Capacitor, Electrolytic, 47 µF, 20%, 16 V	0510170-006
C114	Capacitor, Electrolytic, 22 µF, 20%, 16 V	0510170-007
C115	Capacitor, Electrolytic, 22 µF, 20%, 16 V	0510170-007
C116	Capacitor, Metalized Polyester, 0.1 µF, 10%, 50 V	0610164-104
C117	Capacitor, Ceramic Disc, 0.1 F, +80 -20%, 10 V	0410036-001
C118	Capacitor, Ceramic Disc, 0.1 F, +80 -20%, 10 V	0410036-001
C140	Capacitor, Silver Mica, 1 pF, 10%, 300 V	1010005-010
C141	Capacitor, Metalized Polyester, 0.1 µF, 10%, 50 V	0610164-104
C142	Capacitor, Metalized Polyester, 1.0 µF, 10%, 50 V	0610165-105
C143	Capacitor, Ceramic Disc, 0.1 µF, +80 -20%, 10 V	0410036-001
C144	Capacitor, Ceramic Disc, 0.1 µF, +80 -20%, 10 V	0410036-001
C152	Capacitor, Ceramic Disc, 100 pF, 20%, 500 V	0401022
C153	Capacitor, Electrolytic, 22 µF, 20%, 16 V	0510170-007
C154	Capacitor, Electrolytic, 47 µF, 20%, 16 V	0510170-006
C155	Capacitor, Ceramic Disc, 0.1 µF, +80 -20%, 10 V	0410036-001
C156	Capacitor, Electrolytic, 47 µF, 20%, 16 V	0510170-006
C158	Capacitor, Electrolytic, 220 µF, 20%, 10 V	0510170-020
C160	Capacitor, Silver Mica, 39 pF, 10%, 300 V	1010005-390
C171	Capacitor, Mica, 390 pF, 5%, 100 V	1010006-391
C172	Capacitor, Metalized Polyester, 0.0022 µF, 10%, 50 V	0610164-222
C173	Capacitor, Electrolytic, 1 µF, 20%, 50 V	0510170-015
C181	Capacitor, Metalized Polyester, 2.2 µF, 10%, 50 V	0610165-225
C182	Capacitor, Ceramic Disc, 0.1 µF, +80 -20%, 10 V	0410036-001
C183	Capacitor, Ceramic Disc, 0.1 µF, +80 -20%, 10 V	0410036-001
C201	Capacitor, Ceramic Disc, 0.02 µF, ±20%, 1.4 kV	0410013-001
C203	Capacitor, Electrolytic, 1000 F, -20 +75%, 25 V	0510166-108
C204	Capacitor, Electrolytic, 1000 F, -20 +75%, 25 V	0510166-108
C205	Capacitor, Electrolytic, 47 µF, 20%, 16 V	0510170-006
C206	Capacitor, Electrolytic, 100 µF, -20 +75%, 10 V	0510166-908
C207	Capacitor, Electrolytic, 100 µF, -20 +75%, 10 V	0510166-908
C208	Capacitor, Electrolytic, 1 µF, 20%, 50 V	0510170-015
C209	Capacitor, Electrolytic, 470 µF, -20 +75%, 16 V	0510166-471
C211	Capacitor, Electrolytic, 47 µF, 20%, 16 V	0510170-006
C212	Capacitor, Electrolytic, 470 µF, -20 +75%, 6.3 V	0510166-478
C221	Capacitor, Metalized Polyester, 0.047 µF, 10%, 50 V	0610164-473
C222	Capacitor, Metalized Polyester, 0.047 µF, 10%, 50 V	0610164-473
C223	Capacitor, Ceramic Disc, 0.001 µF, 20%, 500 V	0401046

Table 6-5. Parts List, Type 8329211-001 Video/Auto/Power Supply Board (A2)(Continued)

REF DESIG	DESCRIPTION	PART NUMBER
C224	Capacitor, Mica, 8200 pF, 1%, 500 V	1010016-003
C225	Capacitor, Metalized Polyester, 0.047 µF, 10%, 50 V	0610164-473
C301	Capacitor, Metalized Polyester, 0.01 µF, 10%, 50 V	0610164-103
C341	Capacitor, Metalized Polyester, 0.22 F, 10%, 50 V	0610165-224
CR81	Diode, Switching (1N4148)	3510042-029
CR82	Diode, Switching (1N4148)	3510042-029
CR83	Diode, Switching (1N4148)	3510042-029
CR171	Diode, Switching (1N4148)	3510042-029
CR201	Bridge Rectifier (Int'l Rectifier 2KBP005)	3510112-001
CR221	Diode, Hot Carrier, 0.6 Vf, 20 VRB (Motorola MBD201)	3510096-002
DL111	Delay Line, 60 ns, 12 ns Rise Time, 500 Ohm	4910055-001
J999	Pin, Circuit Board, 0.025 inch Square, 1 each (32 on board)	1310321-001
J12	Connector, Male Pins, 2	1310313-302
J13	Socket, Integrated Circuit, 14-DIP	1710292-007
J14	Socket, Integrated Circuit, 14-DIP	1710292-007
J15	Jumper Assembly, 8 Pin	1710368-108
JB501	Jumper Block, 2 Socket	1710368-001
JB502	Jumper Block, 2 Socket	1710368-001
JB601	Jumper Block, 2 socket	1710319-001
L51	Inductor, 18 µH, 10%, 2.25 Ohm Dc Max, Qmin 75 at 2.5 MHz	2310067-023
L52	Inductor, 18 µH, 10%, 2.25 Ohm Dc Max, Qmin 75 at 2.5 MHz	2310067-023
L53	Inductor, 18 µH, 10%, 2.25 Ohm Dc Max, Qmin 75 at 2.5 MHz	2310067-023
MP501	Heat Sink, Black Anodized, TO-220 Case	2010690-001
MP502	Heat Sink, Black Anodized, TO-220 Case	2010690-001
MP503	Heat Sink, Black Anodized, TO-220 Case	2010690-001
Q1	Transistor, Silicon, PNP, TO-92 Case, 2N4126	7210072-003
Q2	Transistor, Silicon, PNP, TO-92 Case, 2N4126	7210072-003
Q3	Transistor, Silicon, PNP, TO-92 Case, 2N4126	7210072-003
Q4	Transistor, Silicon, NPN, TO-92 Case, 2N4124	7210072-002
Q5	Transistor, Silicon, NPN, TO-92 Case, 2N4124	7210072-002
Q6	Transistor, Silicon, NPN, TO-92 Case, 2N4124	7210072-002
Q21	Transistor, Silicon, NPN, TO-92 Case, 2N4124	7210072-002
Q22	Transistor, Silicon, NPN, TO-92 Case, 2N4124	7210072-002
Q23	Transistor, Silicon, NPN, TO-92 Case, 2N4124	7210072-002
Q31	Transistor, Silicon, NPN, TO-92 Case, 2N4124	7210072-002
Q51	Transistor, Silicon, NPN, TO-92 Case, 2N4124	7210072-002
Q111	Transistor, Silicon, PNP, TO-92 Case, 2N4126	7210072-003
Q112	Transistor, Silicon, PNP, TO-92 Case, 2N4126	7210072-003
Q141	Transistor, Silicon, NPN, TO-92 Case, 2N4124	7210072-002
Q142	Transistor, Silicon, PNP, TO-92 Case, 2N4126	7210072-003

Table 6-5. Parts List, Type 8329211-001 Video/Auto/Power Supply Board (A2)(Continued)

REF DESIG	DESCRIPTION	PART NUMBER
Q171	Transistor, Silicon, NPN, TO-92 Case, 2N4124	7210072-002
Q172	Transistor, Silicon, PNP, TO-92 Case, 2N4126	7210072-003
Q301	Transistor, Silicon, NPN, TO-92 Case, 2N4124	7210072-002
Q302	Transistor, Silicon, NPN, TO-92 Case, 2N4124	7210072-002
Q303	Transistor, Silicon, NPN, TO-92 Case, 2N4124	7210072-002
Q304	Transistor, Silicon, NPN, TO-92 Case, 2N4124	7210072-002
R1	Resistor, Variable, 500 Ohm, 20%, 1/2 W	5010220-501
R2	Resistor, Variable, 500 Ohm, 20%, 1/2 W	5010220-501
R3	Resistor, Carbon Film, 750 Ohm, 5%, 1/4 W	4010025-751
R4	Resistor, Carbon Film, 1000 Ohm, 5%, 1/4 W	4010025-102
R5	Resistor, Carbon Film, 750 Ohm, 5%, 1/4 W	4010025-751
R6	Resistor, Carbon Film, 2700 Ohm, 5%, 1/4 W	4010025-272
R7	Resistor, Carbon Film, 2700 Ohm, 5%, 1/4 W	4010025-272
R8	Resistor, Carbon Film, 1800 Ohm, 5%, 1/4 W	4010025-182
R9	Resistor, Carbon Film, 1800 Ohm, 5%, 1/4 W	4010025-182
R10	Resistor, Carbon Film, 1800 Ohm, 5%, 1/4 W	4010025-182
R11	Resistor, Carbon Film, 6200 Ohm, 5%, 1/4 W	4010025-622
R12	Resistor, Carbon Film, 10 Kilohm, 5%, 1/4 W	4010025-103
R13	Resistor, Carbon Film, 470 Ohm, 5%, 1/4 W	4010025-471
R14	Resistor, Carbon Film, 470 Ohm, 5%, 1/4 W	4010025-471
R15	Resistor, Carbon Film, 470 Ohm, 5%, 1/4 W	4010025-471
R16	Resistor, Carbon Film, 2200 Ohm, 5%, 1/4 W	4010025-222
R17	Resistor, Carbon Film, 2200 Ohm, 5%, 1/4 W	4010025-222
R18	Resistor, Carbon Film, 2200 Ohm, 5%, 1/4 W	4010025-222
R19	Resistor, Carbon Film, 2700 Ohm, 5%, 1/4 W	4010025-272
R21	Resistor, Carbon Film, 1800 Ohm, 5%, 1/4 W	4010025-182
R22	Resistor, Carbon Film, 1800 Ohm, 5%, 1/4 W	4010025-182
R23	Resistor, Carbon Film, 1800 Ohm, 5%, 1/4 W	4010025-182
R24	Resistor, Carbon Film, 2400 Ohm, 5%, 1/4 W	4010025-242
R25	Resistor, Carbon Film, 2400 Ohm, 5%, 1/4 W	4010025-242
R26	Resistor, Carbon Film, 2400 Ohm, 5%, 1/4 W	4010025-242
R27	Resistor, Carbon Film, 47 Ohm, 5%, 1/4 W	4010025-470
R28	Resistor, Carbon Film, 47 Ohm, 5%, 1/4 W	4010025-470
R29	Resistor, Carbon Film, 47 Ohm, 5%, 1/4 W	4010025-470
R31	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R32	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R33	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R34	Resistor, Carbon Film, 1000 Ohm, 5%, 1/4 W	4010025-102
R37	Resistor, Carbon Film, 10 Kilohm, 5%, 1/4 W	4010025-103
R38	Resistor, Carbon Film, 68 Kilohm, 5%, 1/4 W	4010025-683

Table 6-5. Parts List, Type 8329211-001 Video/Auto/Power Supply Board (A2)(Continued)

REF DESIG	DESCRIPTION	PART NUMBER
R41	Resistor, Carbon Film, 2200 Ohm, 5%, 1/4 W	4010025-222
R42	Resistor, Carbon Film, 5100 Ohm, 5%, 1/4 W	4010025-512
R43	Resistor, Variable, 200 Ohm, 20%, 1/2 W	5010220-201
R44	Resistor, Carbon Film, 2400 Ohm, 5%, 1/4 W	4010025-242
R45	Resistor, Carbon Film, 100 Ohm, 5%, 1/4 W	4010025-101
R46	Resistor, Carbon Film, 100 Ohm, 5%, 1/4 W	4010025-101
R47	Resistor, Carbon Film, 240 Ohm, 5%, 1/4 W	4010025-241
R48	Resistor, Variable, 200 Ohm, 20%, 1/2 W	5010220-201
R51	Resistor, Carbon Film, 510 Ohm, 5%, 1/4 W	4010025-511
R52	Resistor, Carbon Film, 510 Ohm, 5%, 1/4 W	4010025-511
R53	Resistor, Carbon Film, 820 Ohm, 5%, 1/4 W	4010025-821
R54	Resistor, Carbon Film, 1800 Ohm, 5%, 1/4 W	4010025-182
R55	Resistor, Carbon Film, 270 Kilohm, 5%, 1/4 W	4010025-274
R56	Resistor, Carbon Film, 4700 Ohm, 5%, 1/4 W	4010025-472
R57	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R58	Resistor, Carbon Film, 3300 Ohm, 5%, 1/4 W	4010025-332
R59	Resistor, Carbon Film, 100 Ohm, 5%, 1/4 W	4010025-101
R60	Resistor, Carbon Film, 3.3 Megohm, 5%, 1/4 W	4010025-335
R61	Resistor, Variable, 10 Turn Linear, 10 Kilohm 5%, 1.8 W	5010232-103
R62	Resistor, Carbon Film, 820 Ohm, 5%, 1/4 W	4010025-821
R63	Resistor, Carbon Film, 220 Ohm, 5%, 1/4 W	4010025-221
R64	Resistor, Carbon Film, 47 Kilohm, 5%, 1/4 W	4010025-473
R65	Resistor, Carbon Film, 11 Kilohm, 5%, 1/4 W	4010025-113
R66	Resistor, Carbon Film, 5100 Ohm, 5%, 1/4 W	4010025-512
R67	Resistor, Carbon Film, 18 Kilohm, 5%, 1/4 W	4010025-183
R68	Resistor, Variable, 10 Turn Linear, 200 Ohm 5%, 1.8 W	5010232-202
R69	Resistor, Carbon Film, 5600 Ohm, 5%, 1/4 W	4010025-562
R70	Resistor, Carbon Film, 5600 Ohm, 5%, 1/4 W	4010025-562
R71	Resistor, Carbon Film, 2200 Ohm, 5%, 1/4 W	4010025-222
R72	Resistor, Carbon Film, 120 Kilohm, 5%, 1/4 W	4010025-124
R74	Resistor, Carbon Film, 10 Kilohm, 5%, 1/4 W	4010025-103
R75	Resistor, Carbon Film, 1200 Ohm, 5%, 1/4 W	4010025-122
R76	Resistor, Variable, 20 Kilohm, +20%, 1/2 W	5010220-203
R77	Resistor, Variable, 5000 ohm, 20%, 1/2 W	5010220-502
R80	Resistor, Carbon Film, 680 Kilohm, 5%, 1/4 W	4010025-684
R81	Resistor, Carbon Film, 1800 Ohm, 5%, 1/4 W	4010025-182
R82	Resistor, Carbon Film, 10 Kilohm, 5%, 1/4 W	4010025-103
R83	Resistor, Carbon Film, 4700 Ohm, 5%, 1/4 W	4010025-472
R84	Resistor, Carbon Film, 1300 Ohm, 5%, 1/4 W	4010025-132
R85	Resistor, Carbon Film, 2400 Ohm, 5%, 1/4 W	4010025-242

Table 6-5. Parts List, Type 8329211-001 Video/Auto/Power Supply Board (A2)(Continued)

REF DESIG	DESCRIPTION	PART NUMBER
R86	Resistor, Carbon Film, 56 Ohm, 5%, 1/4 W	4010025-560
R87	Resistor, Carbon Film, 3900 Ohm, 5%, 1/4 W	4010025-392
R88	Resistor, Carbon Film, 200 Ohm, 5%, 1/4 W	4010025-201
R89	Resistor, Carbon Film, 2700 Ohm, 5%, 1/4 W	4010025-272
R90	Resistor, Carbon Film, 5600 Ohm, 5%, 1/4 W	4010025-562
R91	Resistor, Carbon Film, 3600 Ohm, 5%, 1/4 W	4010025-362
R92	Resistor, Carbon Film, 18 Kilohm, 5%, 1/4 W	4010025-183
R93	Resistor, Variable, 500 Ohm, 20%, 1/2 W	5010220-501
R94	Resistor, Carbon Film, 1300 Ohm, 5%, 1/4 W	4010025-132
R95	Resistor, Carbon Film, 3900 Ohm, 5%, 1/4 W	4010025-392
R96	Resistor, Carbon Film, 430 Ohm, 5%, 1/4 W	4010025-431
R97	Resistor, Carbon Film, 5600 Ohm, 5%, 1/4 W	4010025-562
R98	Resistor, Carbon Film, 2200 Ohm, 5%, 1/4 W	4010025-222
R101	Resistor, Carbon Film, 10 Kilohm, 5%, 1/4 W	4010025-103
R102	Resistor, Carbon Film, 470 Ohm, 5%, 1/4 W	4010025-471
R103	Resistor, Variable, 10 Kilohm, +20%, 1/2 W	5010220-103
R104	Resistor, Carbon Film, 1 Megohm, 5%, 1/4 W	4010025-105
R105	Resistor, Carbon Film, 18 Kilohm, 5%, 1/4 W	4010025-183
R106	Resistor, Variable, 10 Kilohm, +20%, 1/2 W	5010220-103
R107	Resistor, Carbon Film, 1800 Ohm, 5%, 1/4 W	4010025-182
R108	Resistor, Carbon Film, 10 Kilohm, 5%, 1/4 W	4010025-103
R109	Resistor, Carbon Film, 47 Kilohm, 5%, 1/4 W	4010025-473
R110	Resistor, Carbon Film, 120 Kilohm, 5%, 1/4 W	4010025-124
R111	Resistor, Variable, Linear, 2 Kilohm, 10%, 1 W	5010142-203
R112	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R113	Resistor, Carbon Film, 1000 Ohm, 5%, 1/4 W	4010025-102
R114	Resistor, Carbon Film, 470 Ohm, 5%, 1/4 W	4010025-471
R115	Resistor, Variable, CCW Modified Log, 5 Kilohm, 10%, 1 W	5010142-502
R116	Resistor, Carbon Film, 270 Ohm, 5%, 1/4 W	4010025-271
R117	Resistor, Carbon Film, 1000 Ohm, 5%, 1/4 W	4010025-102
R119	Resistor, Carbon Film, 470 Ohm, 5%, 1/4 W	4010025-471
R121	Resistor, Carbon Film, 1000 Ohm, 5%, 1/4 W	4010025-102
R122	Resistor, Carbon Film, 220 Ohm, 5%, 1/4 W	4010025-221
R123	Resistor, Carbon Film, 1000 Ohm, 5%, 1/4 W	4010025-102
R124	Resistor, Carbon Film, 1000 Ohm, 5%, 1/4 W	4010025-102
R125	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R126	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R127	Resistor, Carbon Film, 1000 Ohm, 5%, 1/4 W	4010025-102
R128	Resistor, Carbon Film, 6800 Ohm, 5%, 1/4 W	4010025-682
R129	Resistor, Carbon Film, 470 Ohm, 5%, 1/4 W	4010025-471

Table 6-5. Parts List, Type 8329211-001 Video/Auto/Power Supply Board (A2)(Continued)

REF DESIG	DESCRIPTION	PART NUMBER
R131	Resistor, Variable, 500 Ohm, 20%, 1/2 W	5010220-501
R140	Resistor, Carbon Film, 3.3 Megohm, 5%, 1/4 W	4010025-335
R141	Resistor, Carbon Film, 1800 Ohm, 5%, 1/4 W	4010025-182
R142	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R143	Resistor, Carbon Film, 2400 Ohm, 5%, 1/4 W	4010025-242
R144	Resistor, Carbon Film, 3900 Ohm, 5%, 1/4 W	4010025-392
R145	Resistor, Carbon Film, 47 Kilohm, 5%, 1/4 W	4010025-473
R146	Resistor, Carbon Film, 2200 Ohm, 5%, 1/4 W	4010025-222
R147	Resistor, Variable, 10 Kilohm, +20%, 1/2 W	5010220-103
R148	Resistor, Carbon Film, 5600 Ohm, 5%, 1/4 W	4010025-562
R149	Resistor, Carbon Film, 1500 Ohm, 5%, 1/4 W	4010025-152
R150	Resistor, Carbon Film, 47 Kilohm, 5%, 1/4 W	4010025-473
R151	Resistor, Carbon Film, 1000 Ohm, 5%, 1/4 W	4010025-102
R152	Resistor, Variable, 10 Kilohm, +20%, 1/2 W	5010220-103
R153	Resistor, Carbon Film, 47 Kilohm, 5%, 1/4 W	4010025-473
R154	Resistor, Carbon Film, 4700 Ohm, 5%, 1/4 W	4010025-472
R155	Resistor, Carbon Film, 100 Ohm, 5%, 1/4 W	4010025-101
R156	Resistor, Carbon Film, 1300 Ohm, 5%, 1/4 W	4010025-132
R157	Resistor, Carbon Film, 3900 Ohm, 5%, 1/4 W	4010025-392
R158	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R159	Resistor, Carbon Film, 10 Kilohm, 5%, 1/4 W	4010025-103
R160	Resistor, Carbon Film, 10 Kilohm, 5%, 1/4 W	4010025-103
R161	Resistor, Carbon Film, 820 Ohm, 5%, 1/4 W	4010025-821
R162	Resistor, Carbon Film, 68 Ohm, 5%, 1/4 W	4010025-680
R163	Resistor, Carbon Film, 390 Ohm, 5%, 1/4 W	4010025-391
R171	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R172	Resistor, Carbon Film, 11 Kilohm, 5%, 1/4 W	4010025-113
R173	Resistor, Variable, 20 Kilohm, +20%, 1/2 W	5010220-203
R174	Resistor, Carbon Film, 15 Kilohm, 5%, 1/4 W	4010025-153
R175	Resistor, Carbon Film, 15 Kilohm, 5%, 1/4 W	4010025-153
R177	Resistor, Carbon Film, 47 Kilohm, 5%, 1/4 W	4010025-473
R178	Resistor, Carbon Film, 1 Megohm, 5%, 1/4 W	4010025-105
R182	Resistor, Carbon Film, 100 Kilohm, 5%, 1/4 W	4010025-104
R183	Resistor, Carbon Film, 150 Kilohm, 5%, 1/4 W	4010025-154
R184	Resistor, Variable, 10 Kilohm, +20%, 1/2 W	5010220-103
R185	Resistor, Carbon Film, 150 Kilohm, 5%, 1/4 W	4010025-154
R186	Resistor, Carbon Film, 2 Megohm, 5%, 1/4 W	4010025-205
R187	Resistor, Carbon Film, 100 Ohm, 5%, 1/4 W	4010025-101
R188	Resistor, Carbon Film, 15 Kilohm, 5%, 1/4 W	4010025-153
R190	Resistor, Carbon Film, 15 Kilohm, 5%, 1/4 W	4010025-153

Table 6-5. Parts List, Type 8329211-001 Video/Auto/Power Supply Board (A2)(Continued)

REF DESIG	DESCRIPTION	PART NUMBER
R201	Resistor, Carbon Film, 27 Kilohm, 5%, 1/4 W	4010025-273
R202	Resistor, Carbon Film, 200 Kilohm, 5%, 1/4 W	4010025-204
R203	Resistor, Variable, 50 Kilohm, 20%, 1/2 W	5010220-503
R204	Resistor, Carbon Film, 15 Kilohm, 5%, 1/4 W	4010025-153
R205	Resistor, Carbon Film, 240 Ohm, 5%, 1/4 W	4010025-241
R206	Resistor, Carbon Film, 1200 Ohm, 5%, 1/4 W	4010025-122
R207	Resistor, Variable, 1000 ohm, 20%, 1/2 W	5010220-102
R208	Resistor, Carbon Film, 1300 Ohm, 5%, 1/4 W	4010025-132
R209	Resistor, Variable, 5000 Ohm, 20%, 1/2 W	5010220-502
R211	Resistor, Metal Film, 2.00 Kilohm, 1%, 1/4 W	4710051-200
R212	Resistor, Metal Film, 1.21 Kilohm, 1%, 1/4 W	4710051-121
R213	Resistor, Metal Film, 1.00 Kilohm, 1%, 1/4 W	4710051-100
R214	Resistor, Metal Film, 7.68 Kilohm, 1%, 1/4 W	4710051-768
R215	Resistor, Carbon Film, 10 Kilohm, 5%, 1/4 W	4010025-103
R221	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R222	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R223	Resistor, Carbon Film, 150 Kilohm, 5%, 1/4 W	4010025-154
R224	Resistor, Carbon Film, 10 Kilohm, 5%, 1/4 W	4010025-103
R225	Resistor, Carbon Film, 10 Kilohm, 5%, 1/4 W	4010025-103
R226	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R227	Resistor, Metal Film, 576 Kilohm, 1%, 1/4 W	4710053-576
R228	Resistor, Variable, 100 Kilohm, 20%, 1/2 W	5010220-104
R229	Resistor, Metal Film, 309 Kilohm, 1%, 1/4 W	4710053-309
R230	Resistor, Metal Film, 309 Kilohm, 1%, 1/4 W	4710053-309
R231	Resistor, Carbon Film, 1200 Ohm, 5%, 1/4 W	4010025-122
R301	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R302	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R303	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R304	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R305	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R306	Resistor, Carbon Film, 47 Kilohm, 5%, 1/4 W	4010025-473
R307	Resistor, Carbon Film, 10 Kilohm, 5%, 1/4 W	4010025-103
R308	Resistor, Carbon Film, 10 Kilohm, 5%, 1/4 W	4010025-103
R309	Resistor, Variable, 10 Kilohm, +20%, 1/2 W	5010220-103
R311	Resistor, Carbon Film, 470 Kilohm, 5%, 1/4 W	4010025-474
R312	Resistor, Carbon Film, 470 Kilohm, 5%, 1/4 W	4010025-474
R313	Resistor, Carbon Film, 470 Kilohm, 5%, 1/4 W	4010025-474
R314	Resistor, Carbon Film, 470 Ohm, 5%, 1/4 W	4010025-471
R315	Resistor, Carbon Film, 470 Ohm, 5%, 1/4 W	4010025-471
R316	Resistor, Carbon Film, 470 Ohm, 5%, 1/4 W	4010025-471

Table 6-5. Parts List, Type 8329211-001 Video/Auto/Power Supply Board (A2)(Continued)

REF DESIG	DESCRIPTION	PART NUMBER
R317	Resistor, Metal Film, 7.15 Kilohm, 1%, 1/4 W	4710051-715
R318	Resistor, Metal Film, 9.53 Kilohm, 1%, 1/4 W	4710051-953
R319	Resistor, Metal Film, 12.4 Kilohm, 1%, 1/4 W	4710052-124
R321	Resistor, Metal Film, 15.8 Kilohm, 1%, 1/4 W	4710052-158
R322	Resistor, Metal Film, 2.43 Kilohm, 1%, 1/4 W	4710051-243
R323	Resistor, Metal Film, 3.74 Kilohm, 1%, 1/4 W	4710051-374
R324	Resistor, Variable, 1000 Ohm, 20%, 1/2 W	5010220-102
R325	Resistor, Carbon Film, 10 Kilohm, 5%, 1/4 W	4010025-103
R326	Resistor, Carbon Film, 1500 Ohm, 5%, 1/4 W	4010025-152
R331	Resistor, Carbon Film, 22 Kilohm, 5%, 1/4 W	4010025-223
R332	Resistor, Metal Film, 340 Ohm, 1%, 1/4 W	4710050-340
R333	Resistor, Metal Film, 1.02 Kilohm, 1%, 1/4 W	4710051-102
R334	Resistor, Metal Film, 2.00 Kilohm, 1%, 1/4 W	4710051-200
R335	Resistor, Metal Film, 3.4 Kilohm, 1%, 1/4 W	4710051-340
R336	Resistor, Metal Film, 5.11 Kilohm, 1%, 1/4 W	4710051-511
R341	Resistor, Carbon Film, 15 Kilohm, 5%, 1/4 W	4010025-153
R342	Resistor, Carbon Film, 15 Kilohm, 5%, 1/4 W	4010025-153
R343	Resistor, Carbon Film, 15 Kilohm, 5%, 1/4 W	4010025-153
R344	Resistor, Carbon Film, 22 Ohm, 5%, 1/4 W	4010025-220
R345	Resistor, Carbon Film, 10 Kilohm, 5%, 1/4 W	4010025-103
R346	Resistor, Variable, 10 Kilohm, +20%, 1/2 W	5010220-103
RV201	Varistor, Metal Oxide, 130 Vac, 340V/25A Clamp (GE V130LA5)	4910051-002
T201	Transformer, Power, 115/230 Vac to 12 or 24 Vac, 50/60 Hz	6510172-001
TP1	Test Point, Tin Plated Brass	1710280-001
TP171	Test Point, Tin Plated Brass	1710280-001
TP201	Test Point, Tin Plated Brass	1710280-001
TP221	Test Point, Tin Plated Brass	1710280-001
U1	Transistor Array, NPN/PNP, 16 Pin (RCA CA3096M)	3610356-002
U2	Quad Switch, D-MOS FET, 16 DIP (SD5000N)	3610226-001
U3	Transistor Array, 5 NPN, 16-DIP (RCA CA3083)	3610193-001
U4	Operational Amplifier, High Speed, 8 DIP (National LM6361N)	3610355-001
U5	IC, Agc/Auto-iris, Video (Sony CX10046)	3610357-001
U10	Transistor Array, NPN/PNP, 16 Pin (RCA CA3096M)	3610356-002
U11	Transistor Array, NPN/PNP, 16 Pin (RCA CA3096M)	3610356-002
U12	Operational Amplifier, High Speed, 8 DIP (National LM6361N)	3610355-001
U13	Operational Amplifier, High Speed, 8 DIP (National LM6361N)	3610355-001
U14	Transistor Array, 5 NPN, 16-DIP (RCA CA3083)	3610193-001
U15	Operational Amplifier, High Speed, 8 DIP (National LM6361N)	3610355-001
U16	Transistor Array, 5 NPN, 16-DIP (RCA CA3083)	3610193-001
U17	Quad Operational Amplifier, 14 DIP (National LM324N)	3610187-001

Table 6-5. Parts List, Type 8329211-001 Video/Auto/Power Supply Board (A2)(Continued)

REF DESIG	DESCRIPTION	PART NUMBER
U18	Transistor Array, NPN/PNP, 16 Pin (RCA CA3096M)	3610356-002
U19	Dual MV, Schmitt Trigger Inputs, 16 DIP (National MM74C221N)	3610214-003
U201	Voltage Regulator, Low Dropout (National LM2931CT)	3610328-001
U202	Voltage Regulator, +8 V dc (Motorola MC7808CT)	3610144-008
U203	Voltage Regulator, +5 V dc (Motorola MC7805CT)	3610144-005
U204	Voltage Regulator, -8 V dc (Motorola MC7908CT)	3610144-108
U205	Voltage Regulator, Adjustable -1.2 to -37 V dc (National LM337LZ)	3610281-002
U206	Voltage Regulator, Adjustable, 3-terminal (Motorola LM317LZ)	3610245-003
U207	Voltage Regulator, Adjustable, 3-terminal (Motorola LM317LZ)	3610245-003
U208	Voltage Regulator, Adjustable, -1.2 to -37 Vdc, (National LM337LZ)	3610281-002
U221	Voltage Comparator, Dual, 8-DIP (Motorola LM393N)	3610191-002
U222	Timer, 8 DIP (Signetics NE555N)	3610147-001
U301	Dot/Bar Display Driver IC, 18 DIP (National LM3914N)	3610300-001
XUDL1	Socket, Integrated Circuit, 14-DIP	1710292-007
XU1	Socket, Integrated Circuit, 16-DIP	1710292-008
XU2	Socket, Integrated Circuit, 16-DIP	1710292-008
XU3	Socket, Integrated Circuit, 16-DIP	1710292-008
XU4	Socket, Integrated Circuit, 8-DIP	1710292-004
XU10	Socket, Integrated Circuit, 16-DIP	1710292-008
XU11	Socket, Integrated Circuit, 16-DIP	1710292-008
XU12	Socket, Integrated Circuit, 8-DIP	1710292-004
XU13	Socket, Integrated Circuit, 8-DIP	1710292-004
XU14	Socket, Integrated Circuit, 16-DIP	1710292-008
XU15	Socket, Integrated Circuit, 8-DIP	1710292-004
XU16	Socket, Integrated Circuit, 16-DIP	1710292-008
XU17	Socket, Integrated Circuit, 14-DIP	1710292-007
XU18	Socket, Integrated Circuit, 16-DIP	1710292-008
XU19	Socket, Integrated Circuit, 16-DIP	1710292-008
XU221	Socket, Integrated Circuit, 8-DIP	1710292-004
XU222	Socket, Integrated Circuit, 8-DIP	1710292-004
XU301	Socket, Integrated Circuit, 18-DIP	1710292-009

Table 6-6. Parts List, Type 8329311-001 Sync/Genlock Board (A3)

REF DESIG	DESCRIPTION	PART NUMBER
	From 8329311-001 Issue 1	
C1	Capacitor, Ceramic, NPO, 220 pF, 5%, 50 V	0410045-019
C2	Capacitor, Ceramic, 0.22 µF, 20%, 50 V	0410042-005
C3	Capacitor, Ceramic, 0.1 µF, 20%, 50 V	0410042-002
C4	Capacitor, Ceramic, NPO, 390 pF, 5%, 50 V	0410045-003
C5	Capacitor, Ceramic, NPO, 390 pF, 5%, 50 V	0410045-003
C6	Capacitor, Tantalum, 1 µF, 20%, 16 V	0510169-007
C7	Capacitor, Variable, 5 to 35 pF, 25 V	0910015-002
C9	Capacitor, Ceramic, NPO, 33 pF, 5%, 50 V	0410045-009
C11	Capacitor, Ceramic, 0.1 µF, 20%, 50 V	0410042-002
C12	Capacitor, Tantalum, 10 µF, 20%, 16 V	0510169-009
C13	Capacitor, Tantulum, 1 µF, 20%, 16 V	0510169-007
C14	Capacitor, Ceramic, NPO, 0.0022 µF, 5%, 50 V	0410045-005
C15	Capacitor, Tantulum, 1 µF, 20%, 16 V	0510169-007
C16	Capacitor, Ceramic, NPO, 0.0022 µF, 5%, 50 V	0410045-005
C17	Capacitor, Variable, 5 to 35 pF, 25 V	0910015-002
C18	Capacitor, Ceramic, NPO, 27 pF, 5%, 50 V	0410045-010
C31	Capacitor, Tantulum, 1 µF, 20%, 16 V	0510169-007
C32	Capacitor, Ceramic, NPO, 390 pF, 5%, 50 V	0410045-003
C33	Capacitor, Ceramic, NPO, 0.0047 µF, 5%, 50 V	0410045-020
C34	Capacitor, Ceramic, NPO, 390 pF, 5%, 50 V	0410045-003
C35	Capacitor, Ceramic, NPO, 0.0047 µF, 5%, 50 V	0410045-020
C36	Capacitor, Ceramic, 0.22 µF, 20%, 50 V	0410042-005
C37	Capacitor, Ceramic, 0.1 µF, 20%, 50 V	0410042-002
C51	Capacitor, Ceramic, 0.1 µF, 20%, 50 V	0410042-002
C52	Capacitor, Tantalum, 2.2 µF, 20%, 6 V	0510169-016
C53	Capacitor, Ceramic, 0.1 µF, 20%, 50 V	0410042-002
C54	Capacitor, Ceramic, 0.1 µF, 20%, 50 V	0410042-002
C55	Capacitor, Ceramic, 0.1 µF, 20%, 50 V	0410042-002
C71	Capacitor, Ceramic, NPO, 0.0056 µF, 5%, 50 V	0410045-022
C72	Capacitor, Ceramic, NPO, 0.0022 µF, 5%, 50 V	0410045-005
C73	Capacitor, Ceramic, NPO, 0.0022 µF, 5%, 50 V	0410045-005
C74	Capacitor, Ceramic, NPO, 47 pF, 5%, 50 V	0410045-013
C75	Capacitor, Ceramic, NPO, 0.0022 µF, 5%, 50 V	0410045-005
C76	Capacitor, Ceramic, NPO, 0.0022 µF, 5%, 50 V	0410045-005
C78	Capacitor, Ceramic, 0.1 µF, 20%, 50 V	0410042-002
C101	Capacitor, Ceramic, 0.1 µF, 20%, 50 V	0410042-002
C102	Capacitor, Ceramic, 0.01 µF, +20%, 50 V	0410042-001
C103	Capacitor, Ceramic, 0.1 µF, 20%, 50 V	0410042-002
C104	Capacitor, Ceramic, 0.1 µF, 20%, 50 V	0410042-002

Table 6-6. Parts List, Type 8329311-001 Sync/Genlock Board (A3)(Continued)

REF DESIG	DESCRIPTION	PART NUMBER
C105	Capacitor, Ceramic, 0.1 μF, 20%, 50 V	0410042-002
C201	Capacitor, Tantalum, 22 μF, 20%, 6 V	0510169-006
C202	Capacitor, Tantalum, 47 μF, 20%, 6 V	0510169-014
CR1	Diode, Switching (Motorola MMBD914)	3510121-001
CR12	Diode, Varactor, 26 to 32 pF (Motorola MMBV109)	3510118-001
CR31	Diode, Switching (Motorola MMBD914)	3510121-001
CR32	Diode, Switching (Motorola MMBD914)	3510121-001
CR33	Diode, Switching (Motorola MMBD914)	3510121-001
CR71	Diode, Switching (Motorola MMBD914)	3510121-001
CR72	Diode, Switching (Motorola MMBD914)	3510121-001
CR73	Diode, Switching (Motorola MMBD914)	3510121-001
CR74	Diode, Switching (Motorola MMBD914)	3510121-001
CR75	Diode, Switching (Motorola MMBD914)	3510121-001
CR76	Diode, Switching (Motorola MMBD914)	3510121-001
CR77	Diode, Switching (Motorola MMBD914)	3510121-001
J21	Socket, 14 DIP	1710292-007
J22	Socket, 14 DIP	1710292-007
J23	Socket, 14 DIP	1710292-007
J501	Jumper Assembly, 3 Pin	1710368-103
J502	Jumper Assembly, 3 Pin	1710368-103
J503	Pin, Circuit Board, 0.025 inch Square	1310321-001
J504	Pin, Circuit Board, 0.025 inch Square	1310321-001
J505	Pin, Circuit Board, 0.025 inch Square	1310321-001
JB501	Jumper Block, 2 Socket	1710368-001
JB502	Jumper Block, 2 Socket	1710368-001
L11	Inductor, 18 H, 10%, Qmin 25 at 2.5 MHz	2310093-002
Q1	MOSFET, Power, NPN (Motorola BSS123)	7210125-001
Q31	Transistor, PNP (Motorola MMBT3906)	7210123-002
Q51	MOSFET, Power, NPN (Motorola BSS123)	7210125-001
Q71	MOSFET, Power, NPN (Motorola BSS123)	7210125-001
Q101	Transistor, PNP (Motorola MMBT3906)	7210123-002
Q102	Transistor, NPN (Motorola MMBT3904)	7210123-001
Q103	Transistor, PNP (Motorola MMBT3906)	7210123-002
Q104	Transistor, NPN (Motorola MMBT3904)	7210123-001
R1	Resistor, Thick Film, 100 Ohm, 5%, 1/8 W	4710043-101
R2	Resistor, Thick Film, 680 Kilohm, 5%, 1/8 W	4710043-684
R3	Resistor, Thick Film, 120 Kilohm, 5%, 1/8 W	4710043-124
R4	Resistor, Thick Film, 10 Kilohm, 5%, 1/8 W	4710043-103
R5	Resistor, Thick Film, 10 Kilohm, 5%, 1/8 W	4710043-103
R6	Resistor, Thick Film, 3.3 Megohm, 5%, 1/8 W	4710043-335

Table 6-6. Parts List, Type 8329311-001 Sync/Genlock Board (A3)(Continued)

REF DESIG	DESCRIPTION	PART NUMBER
R7	Resistor, Thick Film, 1 Megohm, 5%, 1/8 W	4710043-105
R11	Resistor, Thick Film, 10 Kilohm, 5%, 1/8 W	4710043-103
R13	Resistor, Thick Film, 120 Kilohm, 5%, 1/8 W	4710043-124
R14	Resistor, Thick Film, 33 Kilohm, 5%, 1/8 W	4710043-333
R15	Resistor, Thick Film, 10 Megohm, 5%, 1/8 W	4710043-106
R16	Resistor, Thick Film, 220 Kilohm, 5%, 1/8 W	4710043-224
R17	Resistor, Thick Film, 220 Kilohm, 5%, 1/8 W	4710043-224
R18	Resistor, Thick Film, 1.5 Megohm, 5%, 1/8 W	4710043-155
R19	Resistor, Thick Film, 3.3 Megohm, 5%, 1/8 W	4710043-335
R20	Resistor, Thick Film, 56 Kilohm, 5%, 1/8 W	4710043-563
R21	Resistor, Thick Film, 100 Kilohm, 5%, 1/8 W	4710043-104
R22	Resistor, Thick Film, 820 Kilohm, 5%, 1/8 W	4710043-824
R23	Resistor, Thick Film, 8200 Ohm, 5%, 1/8 W	4710043-822
R24	Resistor, Thick Film, 1 Megohm, 5%, 1/8 W	4710043-105
R31	Resistor, Thick Film, 470 Ohm, 5%, 1/8 W	4710043-471
R32	Resistor, Thick Film, 1 Megohm, 5%, 1/8 W	4710043-105
R33	Resistor, Thick Film, 22 Kilohm, 5%, 1/8 W	4710043-223
R34	Resistor, Thick Film, 120 Kilohm, 5%, 1/8 W	4710043-124
R35	Resistor, Variable, 50 Kilohm, 20%, 1/4 W	5010227-503
R36	Resistor, Thick Film, 68 Kilohm, 5%, 1/8 W	4710043-683
R37	Resistor, Thick Film, 4700 Ohm, 5%, 1/8 W	4710043-472
R38	Resistor, Variable, 10 Kilohm, 20%, 1/4 W	5010227-103
R39	Resistor, Variable, 50 Kilohm, 20%, 1/4 W	5010227-503
R40	Resistor, Thick Film, 22 Kilohm, 5%, 1/8 W	4710043-223
R41	Resistor, Thick Film, 1 Megohm, 5%, 1/8 W	4710043-105
R42	Resistor, Thick Film, 10 Kilohm, 5%, 1/8 W	4710043-103
R51	Resistor, Thick Film, 10 Kilohm, 5%, 1/8 W	4710043-103
R52	Resistor, Thick Film, 39 Ohm, 5%, 1/8 W	4710043-390
R53	Resistor, Thick Film, 39 Ohm, 5%, 1/8 W	4710043-390
R54	Resistor, Thick Film, 39 Ohm, 5%, 1/8 W	4710043-390
R55	Resistor, Thick Film, 39 Ohm, 5%, 1/8 W	4710043-390
R56	Resistor, Thick Film, 39 Ohm, 5%, 1/8 W	4710043-390
R57	Resistor, Thick Film, 39 Ohm, 5%, 1/8 W	4710043-390
R58	Resistor, Thick Film, 39 Ohm, 5%, 1/8 W	4710043-390
R59	Resistor, Thick Film, 39 Ohm, 5%, 1/8 W	4710043-390
R60	Resistor, Thick Film, 39 Ohm, 5%, 1/8 W	4710043-390
R61	Resistor, Thick Film, 1000 Ohm, 5%, 1/8 W	4710043-102
R62	Resistor, Thick Film, 1000 Ohm, 5%, 1/8 W	4710043-102
R63	Resistor, Thick Film, 100 Ohm, 5%, 1/8 W	4710043-101
R71	Resistor, Thick Film, 22 Kilohm, 5%, 1/8 W	4710043-223

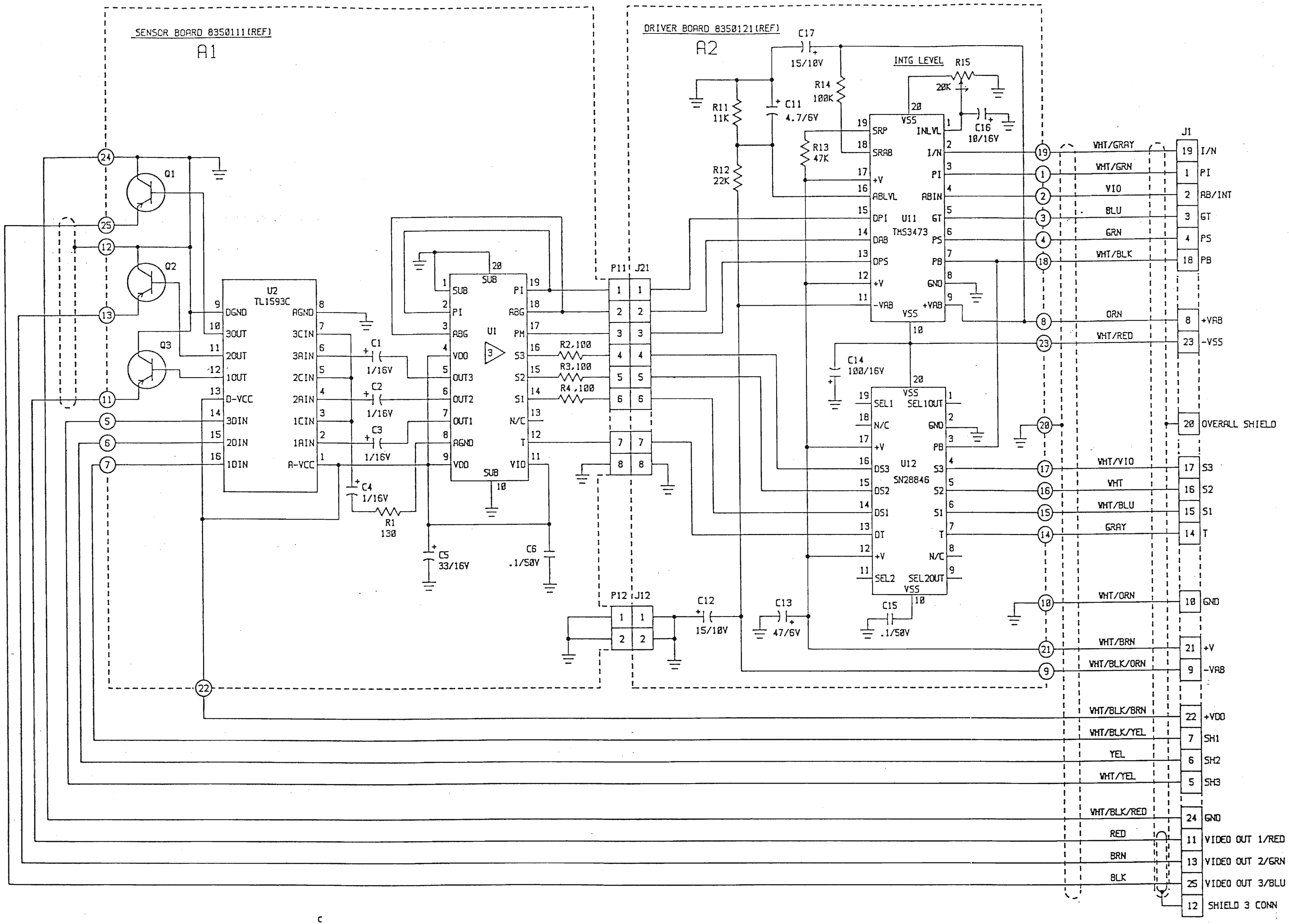
Table 6-6. Parts List, Type 8329311-001 Sync/Genlock Board (A3)(Continued)

REF DESIG	DESCRIPTION	PART NUMBER
R72	Resistor, Variable, 50 Kilohm, 20%, 1/4 W	5010227-503
R73	Resistor, Thick Film, 220 Kilohm, 5%, 1/8 W	4710043-224
R74	Resistor, Thick Film, 27 Kilohm, 5%, 1/8 W	4710043-273
R75	Resistor, Thick Film, 10 Kilohm, 5%, 1/8 W	4710043-103
R76	Resistor, Thick Film, 18 Kilohm, 5%, 1/8 W	4710043-183
R77	Resistor, Thick Film, 47 Kilohm, 5%, 1/8 W	4710043-473
R78	Resistor, Thick Film, 180 Kilohm, 5%, 1/8 W	4710043-184
R79	Resistor, Variable, 50 Kilohm, 20%, 1/4 W	5010227-503
R80	Resistor, Thick Film, 47 Kilohm, 5%, 1/8 W	4710043-473
R82	Resistor, Thick Film, 39 Ohm, 5%, 1/8 W	4710043-390
R83	Resistor, Thick Film, 39 Ohm, 5%, 1/8 W	4710043-390
R84	Resistor, Thick Film, 39 Ohm, 5%, 1/8 W	4710043-390
R85	Resistor, Thick Film, 47 Kilohm, 5%, 1/8 W	4710043-473
R86	Resistor, Thick Film, 150 Kilohm, 5%, 1/8 W	4710043-154
R87	Resistor, Variable, 500 Kilohm, 20%, 1/4 W	5010227-504
R101	Resistor, Thick Film, 39 Kilohm, 5%, 1/8 W	4710043-393
R102	Resistor, Thick Film, 10 Kilohm, 5%, 1/8 W	4710043-103
R103	Resistor, Thick Film, 10 Kilohm, 5%, 1/8 W	4710043-103
R104	Resistor, Thick Film, 100 Kilohm, 5%, 1/8 W	4710043-104
R105	Resistor, Thick Film, 100 Kilohm, 5%, 1/8 W	4710043-104
R106	Resistor, Thick Film, 39 Kilohm, 5%, 1/8 W	4710043-393
R107	Resistor, Thick Film, 10 Kilohm, 5%, 1/8 W	4710043-103
R108	Resistor, Thick Film, 10 Kilohm, 5%, 1/8 W	4710043-103
R109	Resistor, Thick Film, 10 Kilohm, 5%, 1/8 W	4710043-103
R110	Resistor, Thick Film, 10 Kilohm, 5%, 1/8 W	4710043-103
R111	Resistor, Thick Film, 1000 Ohm, 5%, 1/8 W	4710043-102
R112	Resistor, Thick Film, 1000 Ohm, 5%, 1/8 W	4710043-102
R201	Resistor, Thick Film, 22 Ohm, 5%, 1/8 W	4710043-220
TP11	Test Point	1710372-001
TP51	Test Point	1710372-001
TP52	Test Point	1710372-001
TP501	Test Point (Ground)	1710372-001
U1	Video Sync Separator, 8-DIP (National LM1881M)	3610349-002
U2	Retriggerable Monostable MV, 16-Pin (Signetics MC74HC221D)	3610334-004
U3	Analog Multiplexer/Demultiplexers, 16-Pin (Motorola MC14053D)	3610335-002
U4	Quad 2-input Positive NAND, 14-DIP (Motorola MC74HC00D)	3610334-001
U5	Dual Operational Amplifier/Buffer, 8-DIP (Motorola LM358D)	3610295-002
U10	Retriggerable Monostable MV, 16-Pin (Signetics MC74HC221D)	3610334-004
U11	Phase-Locked Loop, 16-Pin (Motorola MC14046D)	3610335-001
U12	Retriggerable Monostable MV, 16-Pin (Signetics MC74HC221D)	3610334-004

Table 6-6. Parts List, Type 8329311-001 Sync/Genlock Board (A3)(Continued)

REF DESIG	DESCRIPTION	PART NUMBER
U51	Timing Generator, NTSC, 44-pin (TI SN28835FS)	3610348-005
U52	Hex Buffer/Line-driver, 16 pin (Motorola MC74HC365D)	3610334-007
U53	Hex Buffer/Line-driver, 16 pin (Motorola MC74HC365D)	3610334-007
U61	Retriggerable Monostable MV, 16-Pin (Signetics MC74HC221D)	3610334-004
U62	Retriggerable Monostable MV, 16-Pin (Signetics MC74HC221D)	3610334-004
U63	Retriggerable Monostable MV, 16-Pin (Signetics MC74HC221D)	3610334-004
U64	Quad 2-input Multiplexer, 16 pin (Motorola MC74HC157D)	3610334-009
U65	Triple 3-Input NOR Gate, 14-Pin (Motorola MC74HC27D)	3610334-012
U101	Quad 2-input Positive NAND, 14-DIP (Motorola MC74HC00D)	3610334-001
U102	Dual D Flip-Flop, 14-Pin (Motorola MC14013D)	3610335-005
U103	Retriggerable Monostable MV, 16-Pin (Signetics MC74HC221D)	3610334-004
Y1	Crystal, 14.318180 MHz 0.001% 20 pF, HC45/U2 Case	3510119-005

SECTION VII
SCHEMATIC DIAGRAMS



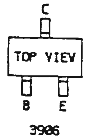
4. ALL PNP TRANSISTORS ARE TYPE 3906.

3 TYPE TC243(B/W), TYPE TC242(COLOR).

2. ALL CAPACITOR VALUES ARE IN MICROFARADS.

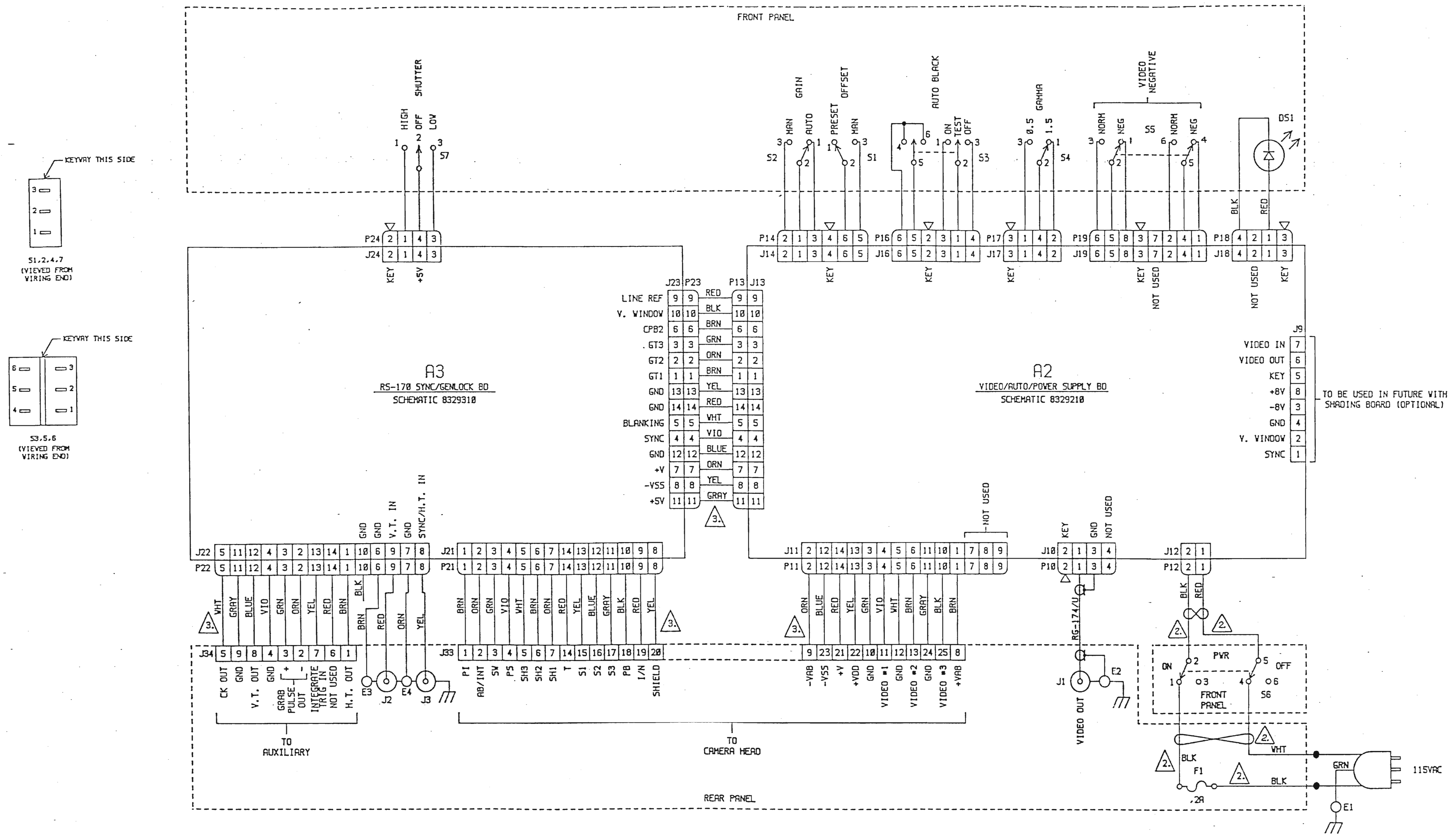
1. ALL RESISTOR VALUES ARE IN OHMS, 1/8W, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED



(from dwg D8350100A)

FIGURE 7-1
Model 6510 Camera Head,
Type 8350121-001 Driver Board, and
Type 8350111-001 Sensor Board
Schematic Diagram



3. RIBBON CABLES 28AWG WIRE.

2. WIRE 22AWG.

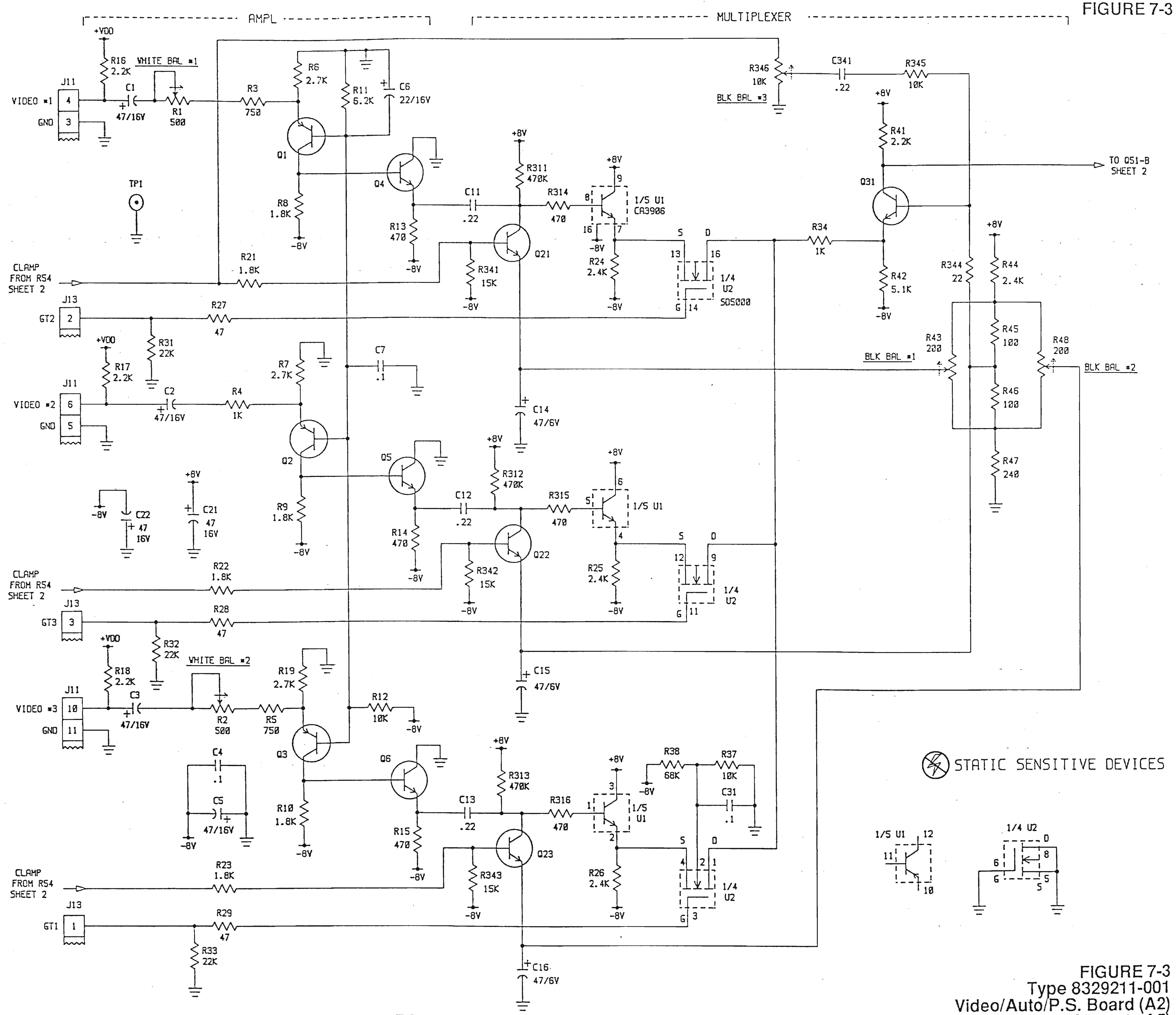
1. ALL WIRES ARE 24AWG.

NOTES: UNLESS OTHERWISE SPECIFIED

(from dwg D8329400B)

FIGURE 7-2
Model 6510 CCU
Schematic Diagram

FIGURE 7-3



1.3 ALL NPN TRANSISTORS ARE TYPE 2N4124.
ALL PNP TRANSISTORS ARE TYPE 2N4126.

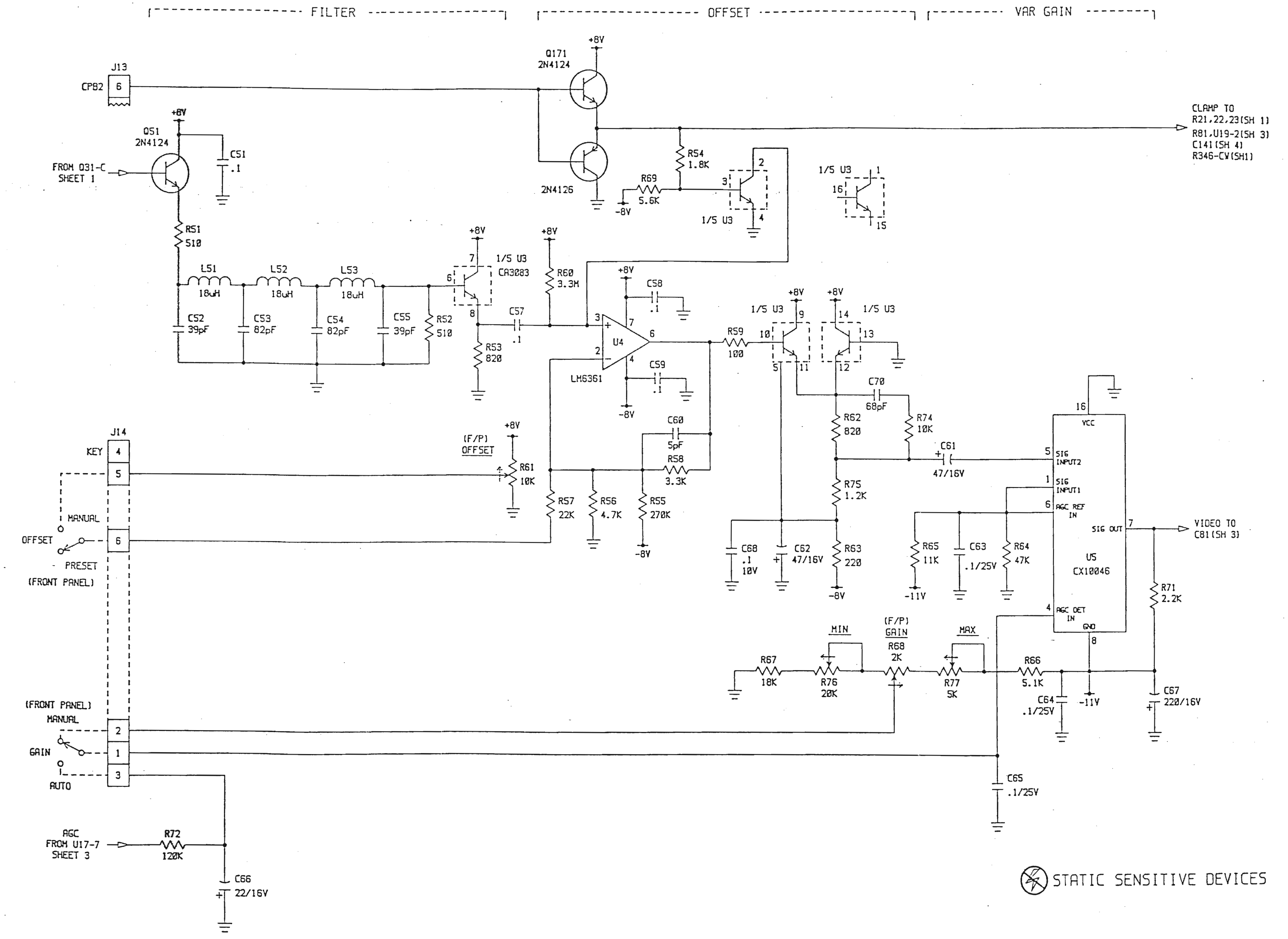
1.2 ALL CAPACITOR VALUES ARE IN MICROFARADS.

1.1 ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED

(from dwg D8329210C)

FIGURE 7-3
Type 8329211-001
Video/Auto/P.S. Board (A2)
Schematic Diagram (Sheet 1 of 5)

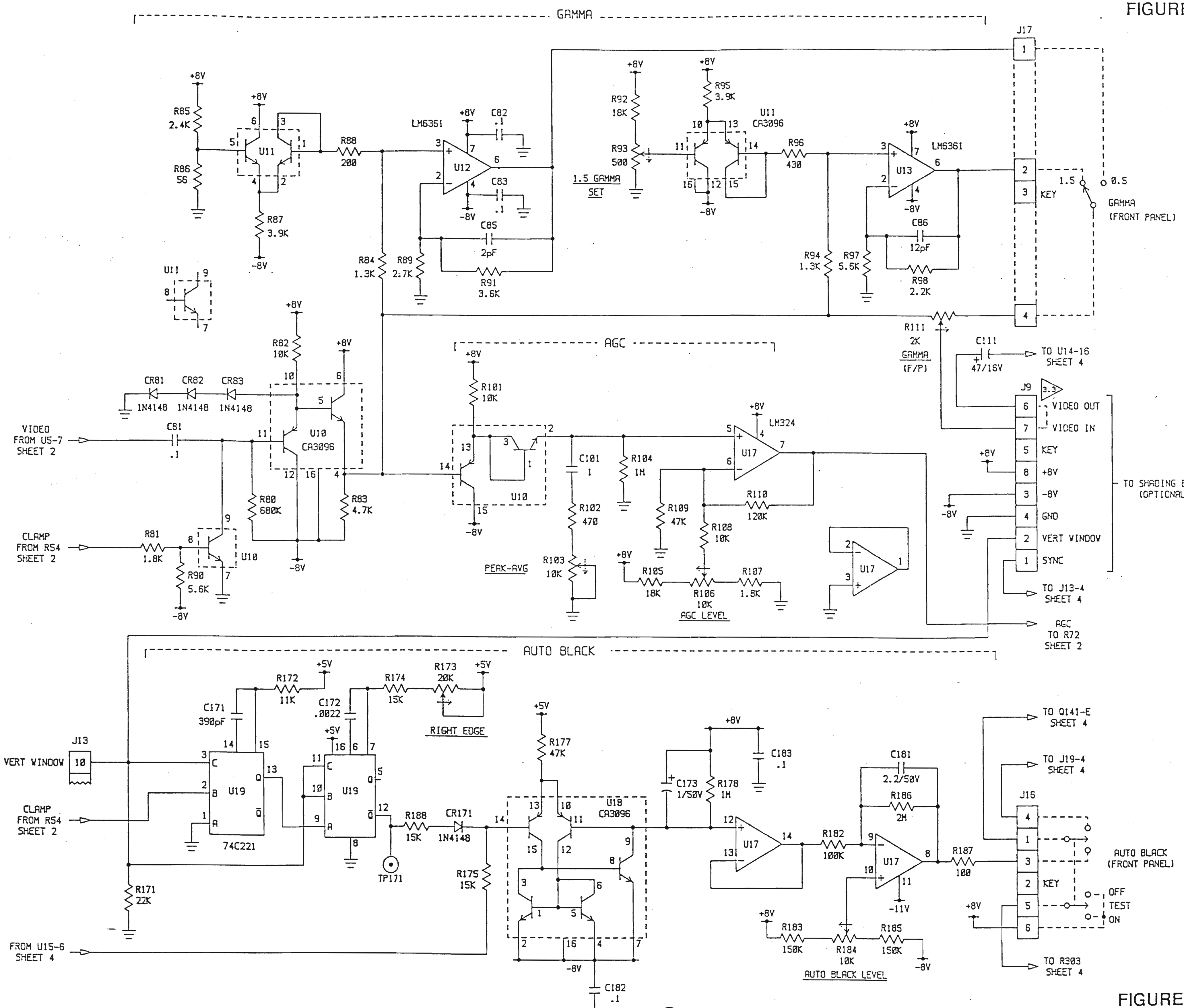


2.2 ALL CAPACITOR VALUES ARE IN MICROFARADS.
2.1 ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%.
NOTES: UNLESS OTHERWISE SPECIFIED

(from dwg D8329210C)

FIGURE 7-3
Type 8329211-001
Video/Auto/P.S. Board (A2)
Schematic Diagram (Sheet 2 of 5)

FIGURE 7-3



3.3 REMOVE JUMPER BLOCK WHEN SHADING BD IS USED.

3.2 ALL CAPACITOR VALUES ARE IN MICROFARADS.

3.1 ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%.

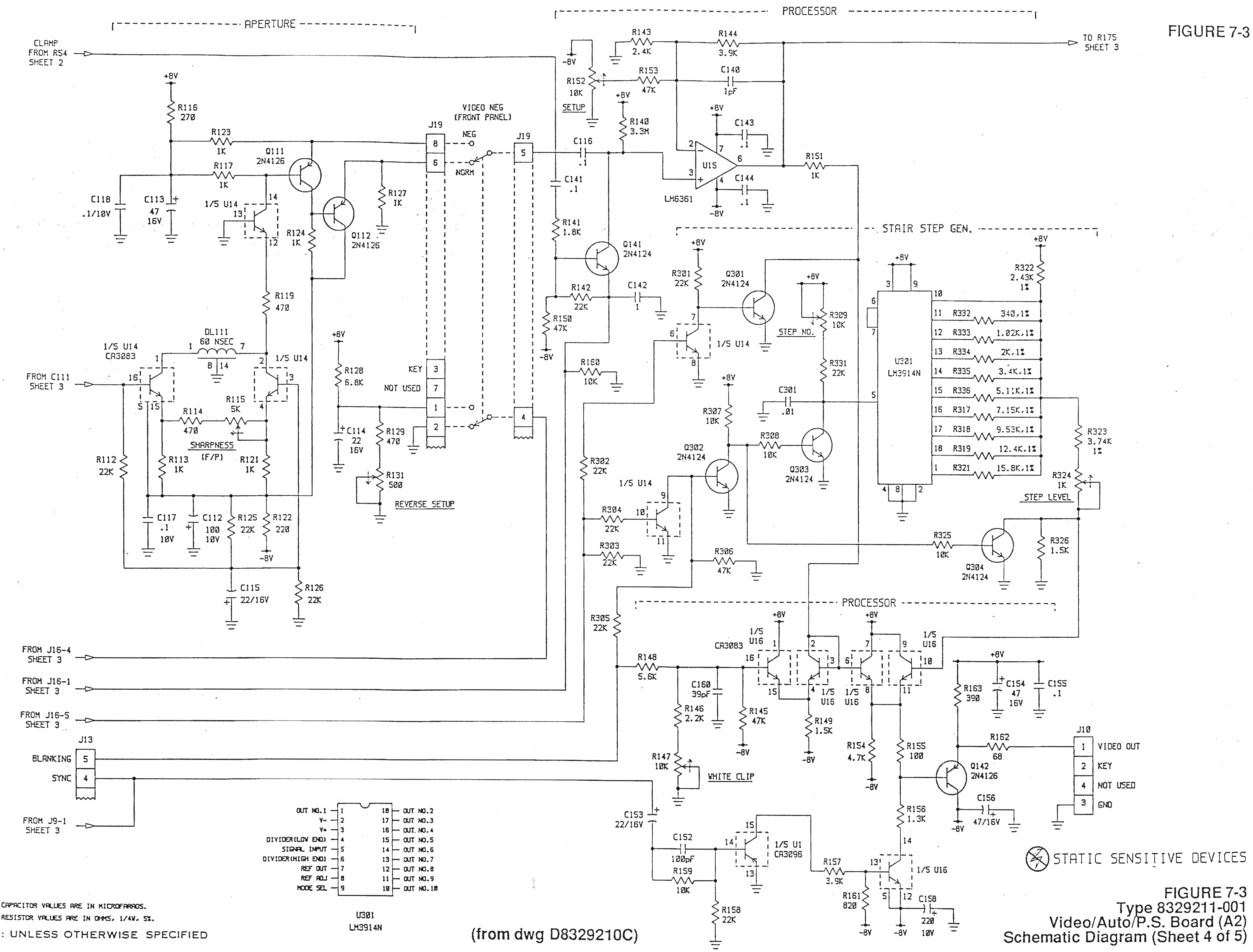
NOTES: UNLESS OTHERWISE SPECIFIED

(from dwg D8329210C)

STATIC SENSITIVE DEVICES

FIGURE 7-3
Type 8329211-001
Video/Auto/P.S. Board (A2)
Schematic Diagram (Sheet 3 of 5)

FIGURE 7-3



4.2 ALL CAPACITOR VALUES ARE IN MICROFARADS.

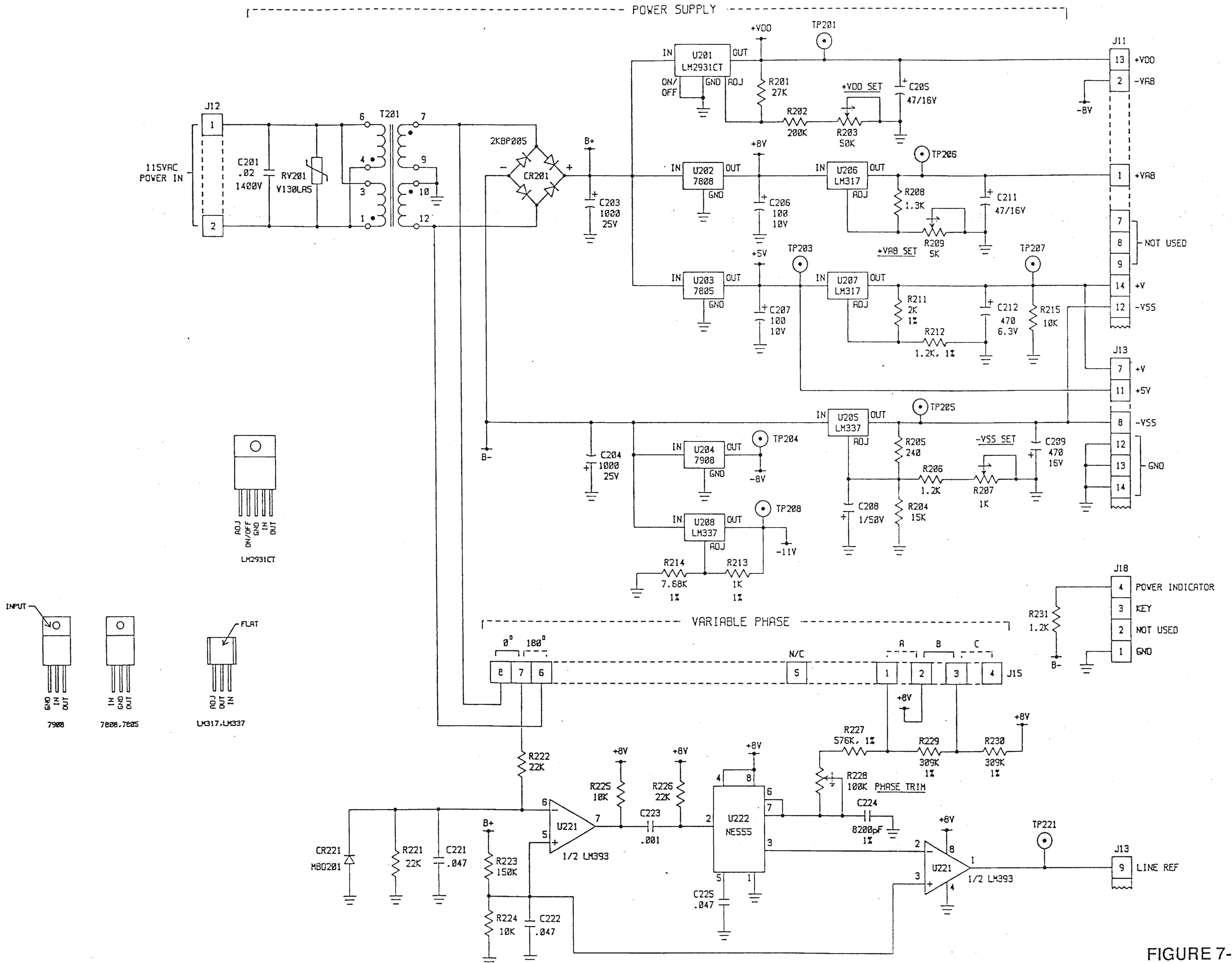
4.1 ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED

(from dwg D8329210C)

FIGURE 7-3
Type 8329211-001
Video/Auto/P.S. Board (A2)
Schematic Diagram (Sheet 4 of 5)

FIGURE 7-3



5.2. ALL CAPACITOR VALUES ARE IN MICROFARADS.

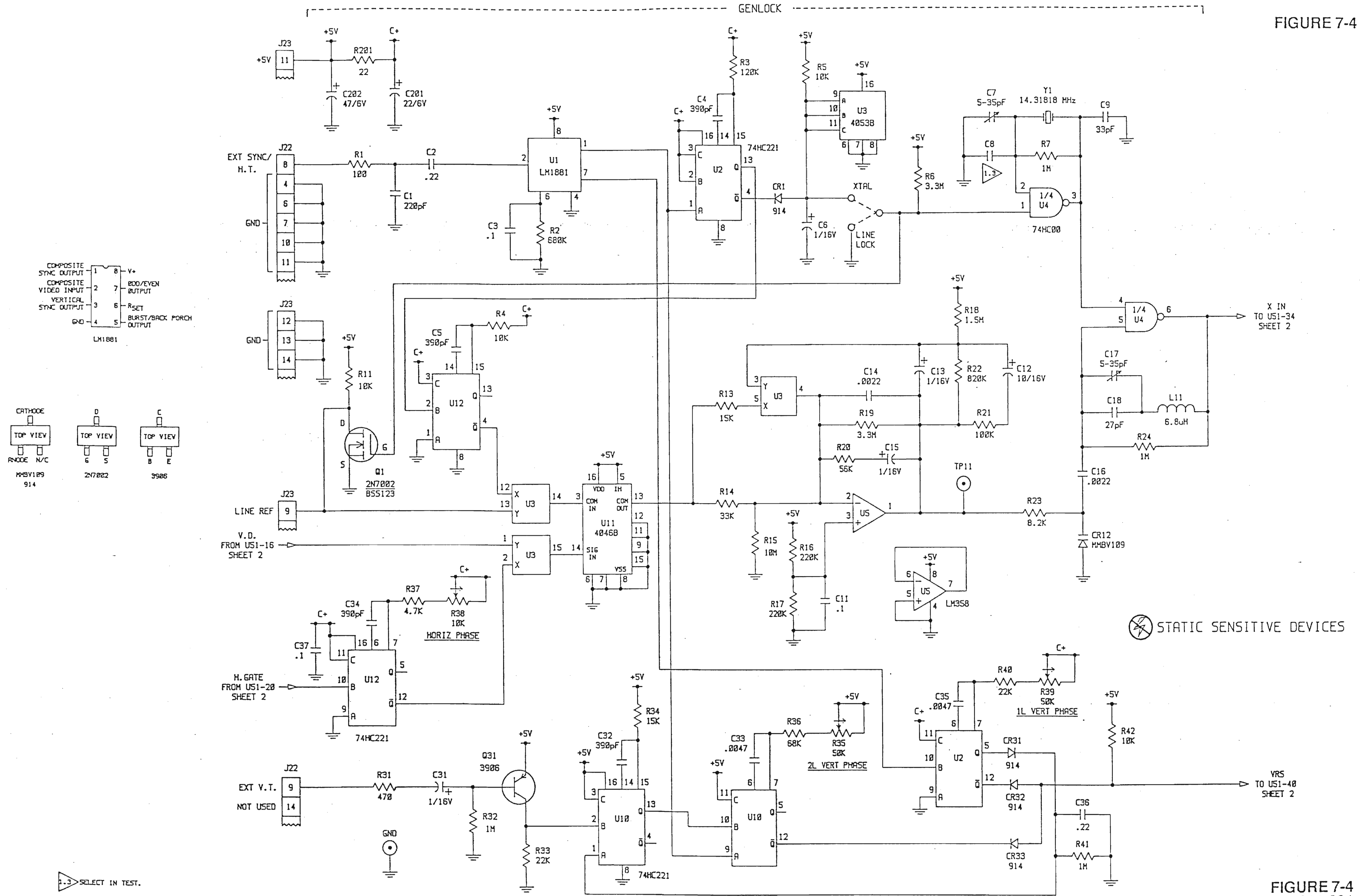
5.1. ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED

(from dwg D8329210C)

FIGURE 7-3
Type 8329211-001
Video/Auto/P.S. Board (A2)
Schematic Diagram (Sheet 5 of 5)

FIGURE 7-4



1.3 SELECT IN TEST.

1.2 ALL CAPACITOR VALUES ARE IN MICROFARADS.

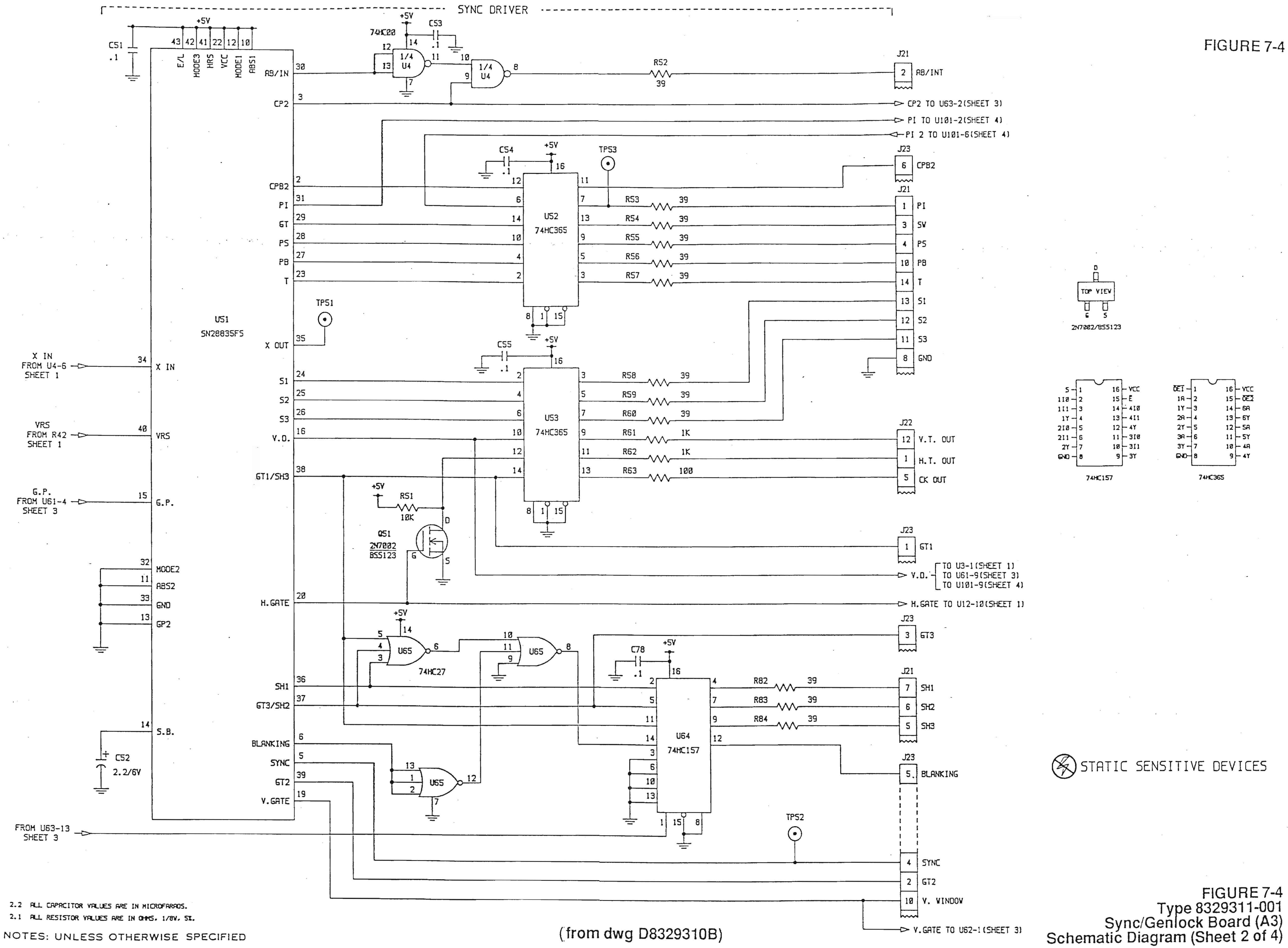
1.1 ALL RESISTOR VALUES ARE IN OHMS, 1/8W, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED

(from dwg D8329310B)

FIGURE 7-4
Type 8329311-001
Sync/Genlock Board (A3)
Schematic Diagram (Sheet 1 of 4)

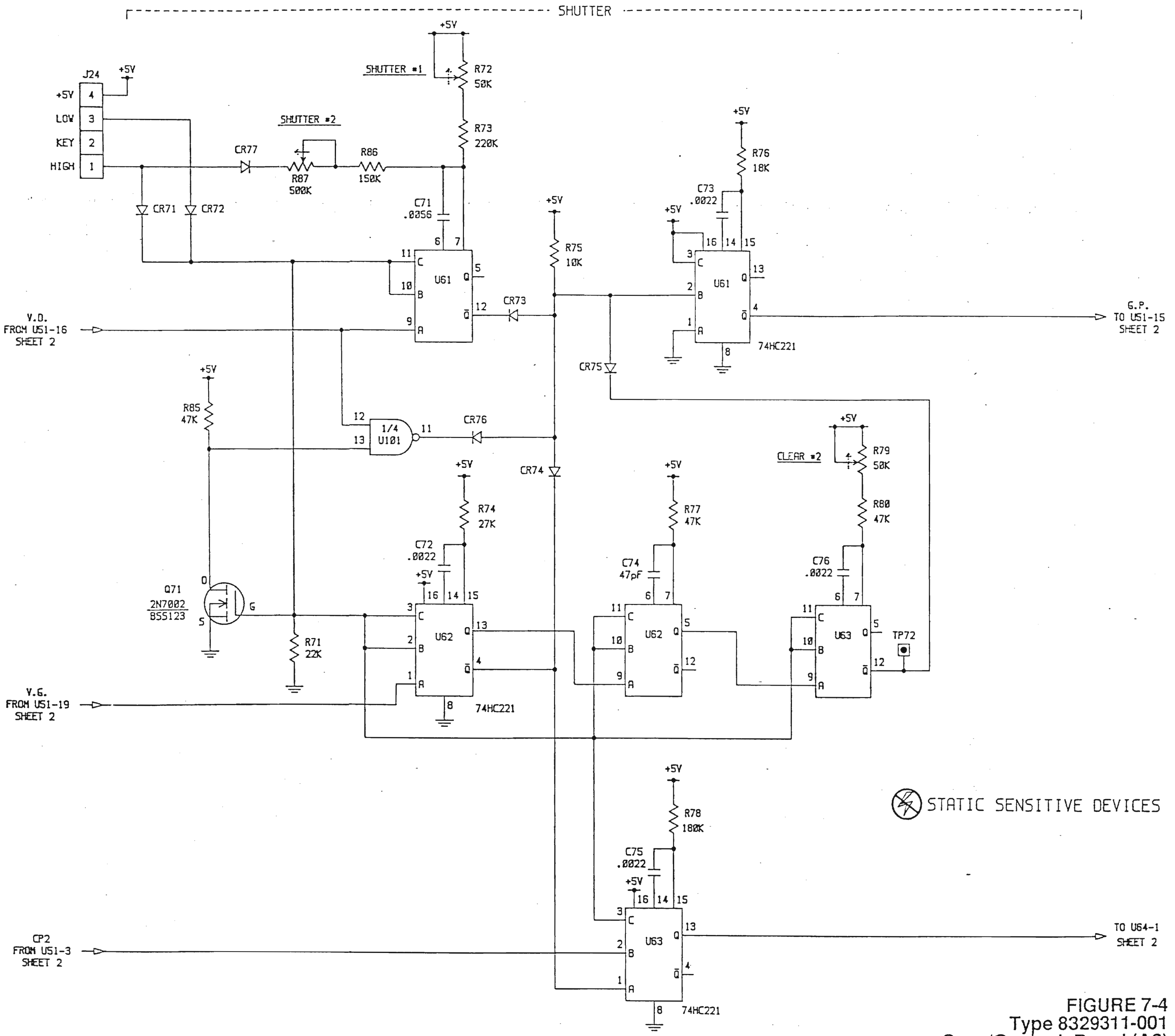
FIGURE 7-4

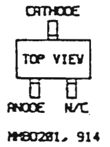


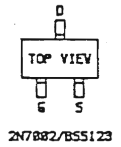
2.2 ALL CAPACITOR VALUES ARE IN MICROFARADS.
2.1 ALL RESISTOR VALUES ARE IN OHMS, 1/8W, 5%.
NOTES: UNLESS OTHERWISE SPECIFIED

(from dwg D8329310B)

FIGURE 7-4
Type 8329311-001
Sync/Genlock Board (A3)
Schematic Diagram (Sheet 2 of 4)



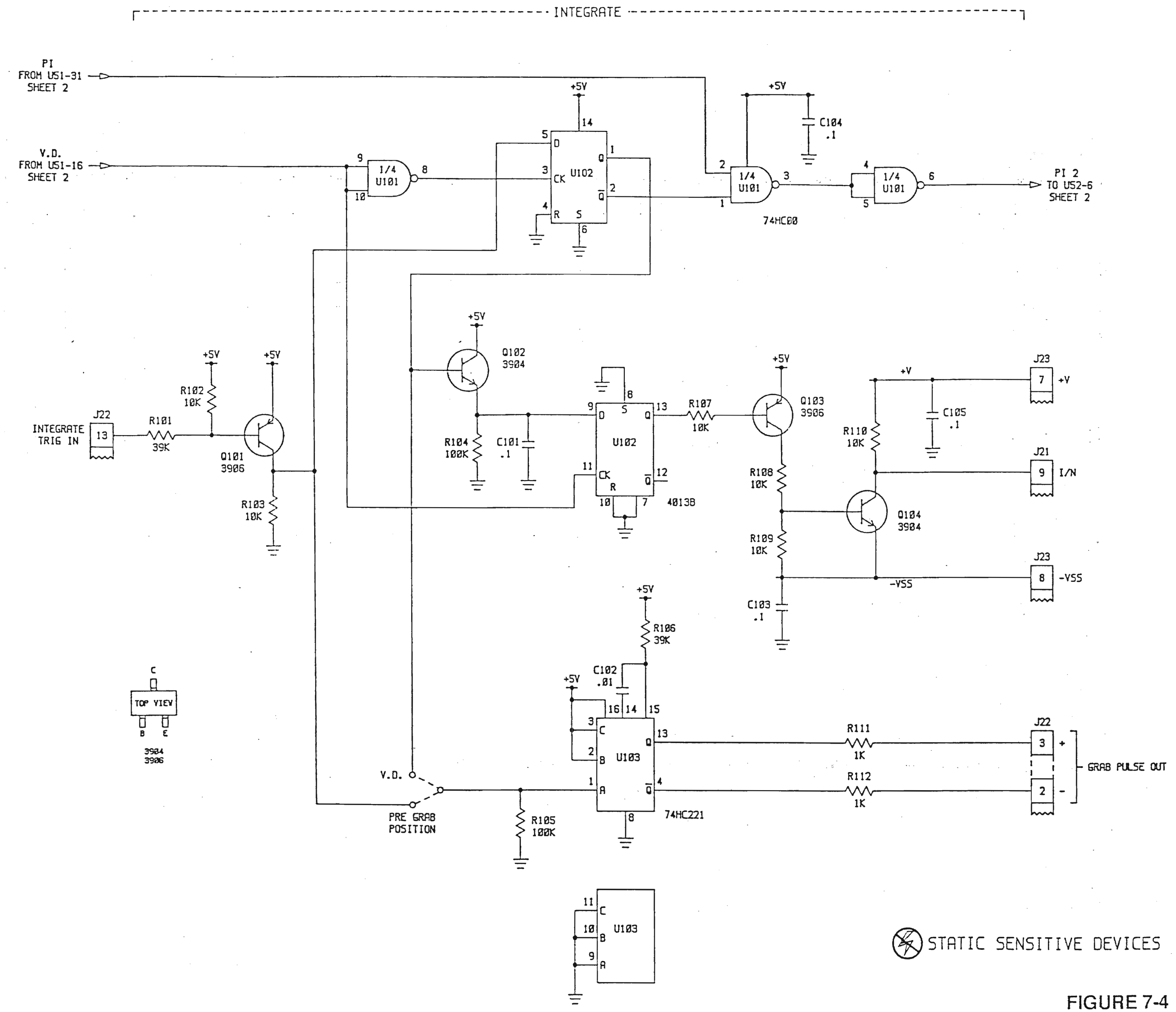




3.3 ALL DIODES ARE TYPE 914.
3.2 ALL CAPACITOR VALUES ARE IN MICROFARADS.
3.1 ALL RESISTOR VALUES ARE IN OHMS, 1/8W, 5%.
NOTES: UNLESS OTHERWISE SPECIFIED

(from dwg D8329310B)

FIGURE 7-4
Type 8329311-001
Sync/Genlock Board (A3)
Schematic Diagram (Sheet 3 of 4)



4.2 ALL CAPACITOR VALUES ARE IN MICROFARADS.
4.1 ALL RESISTOR VALUES ARE IN OHMS, 1/8W, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED

(from dwg D8329310B)

FIGURE 7-4
Type 8329311-001
Sync/Genlock Board (A3)
Schematic Diagram (Sheet 4 of 4)

WARRANTY

Cohu, Inc., Electronics Division warrants equipment manufactured to be free from defects of material and workmanship. Any part or parts will be repaired or replaced when proven by Cohu examination to have been defective within two years from date of shipment to the original purchaser for standard CCD cameras and one year from date of shipment to the original purchaser for intensified CCD cameras and all other Cohu manufactured products. All warranty repairs will be performed at the factory or as otherwise authorized by Cohu in writing. Transportation charges to Cohu shall be prepaid by purchaser.

This warranty does not extend to Cohu equipment subjected to misuse, accident, neglect, or improper application, nor repaired or altered by other than Cohu or those authorized by Cohu in writing. **Television image pickup tubes, image intensifiers, lenses and products manufactured by companies other than Cohu are warranted by the original manufacturer.**

This warranty is in lieu of all other warranties express or implied. Cohu shall not be liable for any collateral or consequential damages.

A Return Authorization (R.A.) Number must be obtained from Cohu prior to returning any item for warranty repair or replacement.

COHU

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